

# International roadmap for consumer packaging

David A. Beeton

*International Roadmap for*  
**Consumer Packaging**

*Exploring the strategic landscape of the packaging sector*

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### **International Roadmap for Consumer Packaging: Exploring the strategic landscape of the packaging sector**

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# Executive Summary

This report presents the findings of twelve roadmapping workshops that brought together almost two hundred delegates representing seventy different organisations from across the packaging sector. It is a product of a three-year research project conducted at the Institute for Manufacturing at the University of Cambridge to capture, structure and communicate the key trends and drivers facing the packaging sector over the next ten years.

The report is presented as a high-level roadmap that illustrates the time horizons in which the trends and drivers are believed to be of greatest importance, and identifies key interactions between them. The ‘architecture’ of the roadmap is used to structure the report, which includes a summary of the key market, product, technology and resource developments identified in the roadmapping workshops, and an in-depth breakdown of the factors that are influencing these generic trends and drivers.

The data presented in the roadmap is entirely sourced from the expert opinion of the workshop participants and should not be regarded as a prescriptive view of how the packaging sector will evolve. The roadmap is intended as a resource to provide useful information, structure and context to strategic planning and innovation processes at both the company and sector level.

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# 1 Introduction

The International Roadmap for Consumer Packaging is a report presenting the findings of a research project surveying the trends and drivers facing the packaging sector. It is intended to capture, structure and communicate these trends and drivers, and provide a framework to support both company and sector-level strategic planning.

It has been developed from information gathered in a series of twelve roadmapping workshops held between June 2004 and March 2005, which were attended by almost two hundred delegates representing seventy different organisations from across the packaging sector. Ten of these workshops were held in the United Kingdom, one in Germany, and one in the U.S.A.

The report presents the key trends and drivers identified by the participants in the workshops, which are illustrated in a series of graphical images. In addition to providing a succinct communication of the range of trends and drivers facing the packaging sector, the images quantify the time horizons in which they are believed to be important, and identify links between individual trends and drivers.

## 1.1 Background

This work is part of a three-year research project, which is being conducted at the Institute for Manufacturing at the University of Cambridge, and funded by the Engineering and Physical Sciences Research Council, the Faraday Packaging Partnership and Pira International.

## 1.2 Aims of the Roadmap

There are three principle aims for the roadmap:

1. To capture and structure the key trends and drivers facing the packaging sector over the next ten years;
2. To communicate detailed insights into the nature and implications of these trends and drivers, including identification of competitive threats and opportunities for innovation;
3. To provide a framework to support strategic planning, decision-making and collaboration in the packaging sector.

It is important to note that the information presented in the roadmap is entirely sourced from the expert opinion of the workshop participants. The intention of the roadmap is not to be a prescriptive view of how the industry will evolve, but to provide a resource to stimulate thought and discussion on the possible development of the packaging sector, and the implications of these changes to the industry.

## 1.3 Structure of the Report

Chapter 2 of this report outlines the roadmapping process, giving an overview of the methodology employed and a description of the ‘architecture’ that was used to structure both the data collection and the presentation of the findings.

Chapter 3 presents a series of headline themes that summarise the key trends and drivers identified in the roadmapping workshops, and illustrate the time horizons in which they are believed to be of greatest importance to the packaging sector. These findings are presented in accordance with the broad layers of the roadmap architecture.

A more detailed account of the range of issues associated with these trends and drivers is presented in Appendices II to V of the report. These give an in-depth breakdown of the challenges and opportunities highlighted in the workshops, and identify specific linkages between individual trends and drivers. This information is also structured in accordance with the broad layers of the roadmap architecture.

## 2 Roadmapping Process

### 2.1 Background

Technology roadmapping is a management tool that is widely used to structure strategic planning initiatives. Although originally intended to support business-level planning, the approach has been extended to sector-level applications, such as the International Semiconductor Roadmap<sup>1</sup>, the Aluminum Industry Roadmap<sup>2</sup> and the Foresight Vehicle Roadmap<sup>3</sup>. A recent report by the Dutch Ministry of Economic Affairs<sup>4</sup> highlights the benefits of roadmapping for ‘supra-company level’ applications, where the proactive nature of the approach is identified as a key advantage, compared to other foresight techniques.

Technology roadmaps can take a wide variety of forms, depending on their intended purpose and the format chosen to represent the information. The approach used in this study is based on ‘T-Plan’<sup>5</sup>, which draws on the knowledge and expertise of individuals in a workshop environment to identify key competitive issues.

### 2.2 Scope of the Roadmap

The delivery of a packaged product to a consumer requires input from an array of companies who are involved in a diverse range of processes and products. This not only includes the incremental stages in the transformation of raw materials into a finished product, but also extends to the transportation, distribution and final

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<sup>1</sup> SIA (2002) International Technology Roadmap for Semiconductors, Semiconductor Industry Association, 1999, <http://public.itrs.net/>.

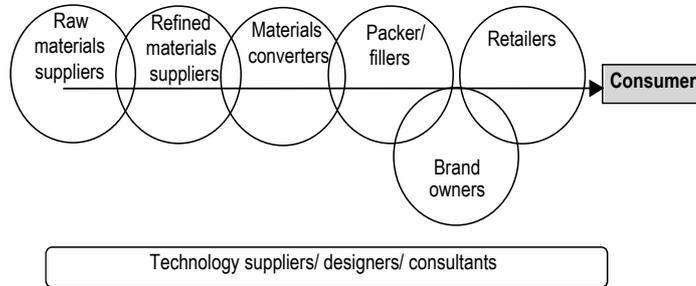
<sup>2</sup> OIT (1997) Aluminum Industry Technology Roadmap, US Office of Industrial Technologies, [www.oit.doe.gov](http://www.oit.doe.gov) and [www.aluminum.org](http://www.aluminum.org).

<sup>3</sup> SMMT (2004) The Foresight Vehicle Technology Roadmap: Technology and Research Directions for Future Road Vehicles, Version 2.0, Society of Motor Manufacturers and Traders Ltd, London, UK.

<sup>4</sup> de Laat, B., and McKibbin, S., (2003) The effectiveness of technology road mapping – building a strategic vision, Dutch Ministry of Economic Affairs, [www.ez.nl](http://www.ez.nl).

<sup>5</sup> Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2001) T-Plan: the fast-start to technology roadmapping – planning your route to success, University of Cambridge Institute for Manufacturing, ISBN 1-902546-09-1.

conveyance of these goods to the consumer. The specific nature of these activities can vary considerably between different product supply chains, but as shown in Figure 1, they can be broadly categorised into a series of actors.



**Figure 1 – Actors involved in packaging supply chains.**

In this study, the roadmapping process incorporated expertise from representatives of each of these categories of stakeholders. The organisations that participated in the process are listed in Figure 2.

Alcan	Faraday Packaging Partnership	Reed Exhibitions
AssiDomän Frövi	Franstech	Rexam
Alcoa	General Mills	Royal College of Art
Amtcor	GlaxoSmithKline	RPC
API Foils	Halfords	SCA
Avery Dennison	Heinz	Sealed Air Corporation
Astra Zeneca	IC Pod	Sheffield Hallam University
Biffa	Imerys	Smurfit Corrugated Ireland
Borealis Group	Innovene	Temptime
Britton Group	Innovia	Tetley
Britvic	Interbrew	Tetrapak
Burall	Kappa Packaging	Toppan
Cadbury Schweppes	Linpac Plastics	Unilever
Caswell Adhesives	Mondi Packaging	Uhlmann
Ciba Specialty Chemicals	M-real	University of Cambridge
Coca Cola	MY Cartons	University of Durham
Conitex Sonoco	Nestle	University of Leeds
Coors	Neusiedler	University of Salford
Crown Packaging	PDD Group	University of Sheffield
Cryovac	Premier Foods	University of York
D S Smith	Pira International	UPM-Kymmene
Diageo	Procter & Gamble	UPM-Walki Wisa
Du Pont	Raflatac	Xaar
Elementis	Reckitt Benckiser	

Figure 2 – Organisations that contributed to the roadmap.

### 2.3 Data Collection

The information presented in this report encapsulates the insights collected in twelve roadmapping workshops. Each of the workshops broadly adhered to the same structure and format. The collection of data was facilitated by a controlled brainstorming process that was structured by a predefined roadmap architecture, which is a framework that enables strategic issues to be oriented by a series of categories and time horizons (explained in Section 2.4). In doing this, the participants were encouraged to draw on their own knowledge and experience to identify what

they considered to be the key strategic issues facing the packaging sector. These issues were recorded as comments written on sticky notes that were placed onto a large wall-mounted chart on which the roadmap architecture had been drawn (as shown in Figure 3). This served to identify the ‘landscape’ of strategic trends and drivers facing the packaging sector.



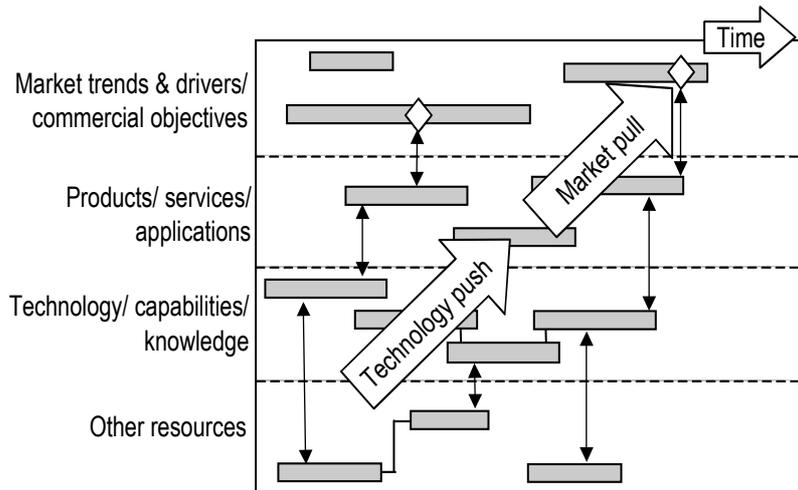
**Figure 3 – Example of the ‘landscape’ of strategic trends and drivers identified in a roadmapping workshop**

## 2.4 Roadmap Architecture

The roadmap architecture is the framework used to structure and communicate the data contained in the roadmap. As shown in Figure 4, this usually takes the form of a time-based chart, with time represented on the horizontal axis, and the vertical axis broken into a number of broad layers.

It is important to note that although the broad layers of the roadmap are considered separately, there is a degree of integration between layers. For example, the top layer

of the roadmap identifies the changing market demands, the second layer considers the developments in products required to satisfy these needs, the third layer signals the technologies that will create these products, and the fourth layer reconciles the provision of resources that support these advances, such as capital, skills and supply chain partnerships. This also works from the bottom to the top, with technological advances creating products and new market applications.



**Figure 4 – A generic technology roadmap.**

In developing the International Roadmap for Consumer Packaging, the architecture remained the same for each of the twelve workshops, and is shown in Figure 5.

The horizontal axis of the roadmap is divided into short, medium and long-term perspectives. The short-term horizon (today → +1 year) classifies current, state-of-the-art and near-market considerations. The medium-term horizon (+1 year → +5 years) identifies more strategic perspectives, and the long-term horizon (+5 years → +10 years) is essentially a ‘radar’ to register possible future commercial and technological opportunities and threats. In addition to these horizons, the architecture categorises historical issues (i.e. events that have occurred in the past, but are currently of influence, or are likely to be an influence in the future) and issues that may occur beyond the long-term time horizon, such as visions, predictions or aspirations.

The vertical axis of the roadmap is broken down into four broad layers, which are in turn divided into various sub-categories. The first broad layer represents the industry, market and business trends and drivers that influence the development of the packaging sector. The second layer represents the performance requirements for packaging in five areas, which were derived from evaluation of the incremental stages in the lifecycle of a packaged product (see Figure 8). The third broad layer is concerned with technological resources in the packaging sector, and the fourth layer captures the development of other resources that are not attributable to the other categories identified, such as capital, skills, organisation, partnerships, and supply chain.

Broad layers	Sub-layers	Time					
		Past	Today	+1 year	+5 years	+10 years	Vision
<b>Market &amp; business</b>	Social						
	Technological						
	Environmental						
	Economic						
	Political						
<b>Product performance areas</b>	Recycling & disposal						
	Use by consumer						
	Retail/ transfer to consumer						
	Transport & warehousing						
	Materials & manufacture						
<b>Technology</b>	Products						
	Processes						
<b>Resources</b>	Development & evolution of other resources						

Figure 5 – Roadmap architecture used in the workshops.

## 2.5 Headline Themes

The information gathered in the twelve workshops was collated under each of the layers on the vertical axis of the roadmap architecture to identify the ‘headline themes’ in each sub-layer. These themes therefore represent the range of issues identified in the workshops. The structure of this process, and the terminology used, is explained in Figure 6.

This enabled the creation of a high-level roadmap, shown in Appendix I, which presents the headline themes together with an indication of when they are likely to impact the sector. The roadmap therefore provides an extensive representation of the key trends and drivers facing the packaging sector. It is important to note that this list should not be considered exhaustive, but simply as representing the range of information that was captured in the workshops.

The headline themes are summarised in Chapter 3, together with an illustration of the time horizons in which it is anticipated they will be of importance. The headline themes are considered in greater depth in Appendices II to V, which detail the full range of insights captured in the roadmapping workshops.

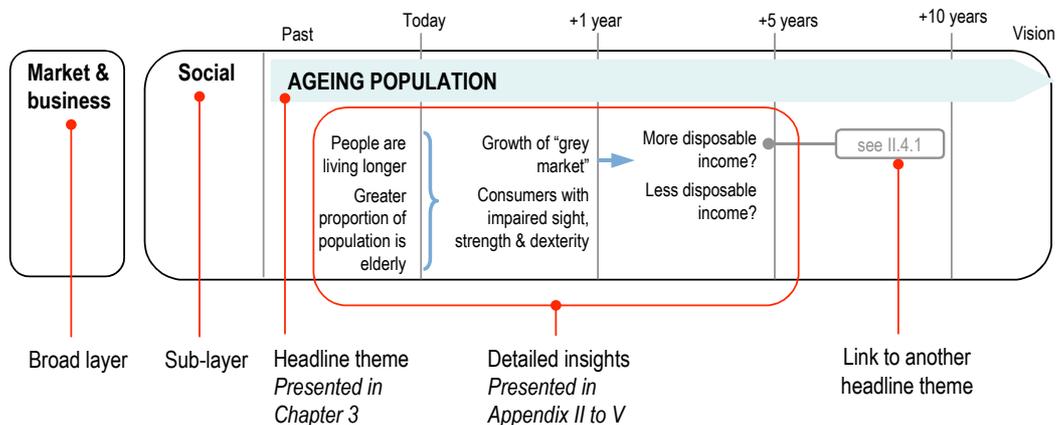


Figure 6 – Key to the information presented in the report

## 3 Packaging Trends and Drivers

### 3.1 Introduction

This chapter outlines the identified headline themes, which provide an overview of the range of trends and drivers that were recorded in the workshops. A diagram is presented for each of the broad layers of the roadmap, identifying the time horizons in which the trends and drivers are believed to be of greatest importance. A brief description of each of the themes is also presented, which summarises the detailed insights that are described in Appendices II to V.

### 3.2 Market and Business Headline Themes

The first broad layer of the roadmap represents the industry, market and business trends and drivers that influence the development of the packaging sector. This is broken down into five generic sub-categories: social, technological, environmental, economic and political.

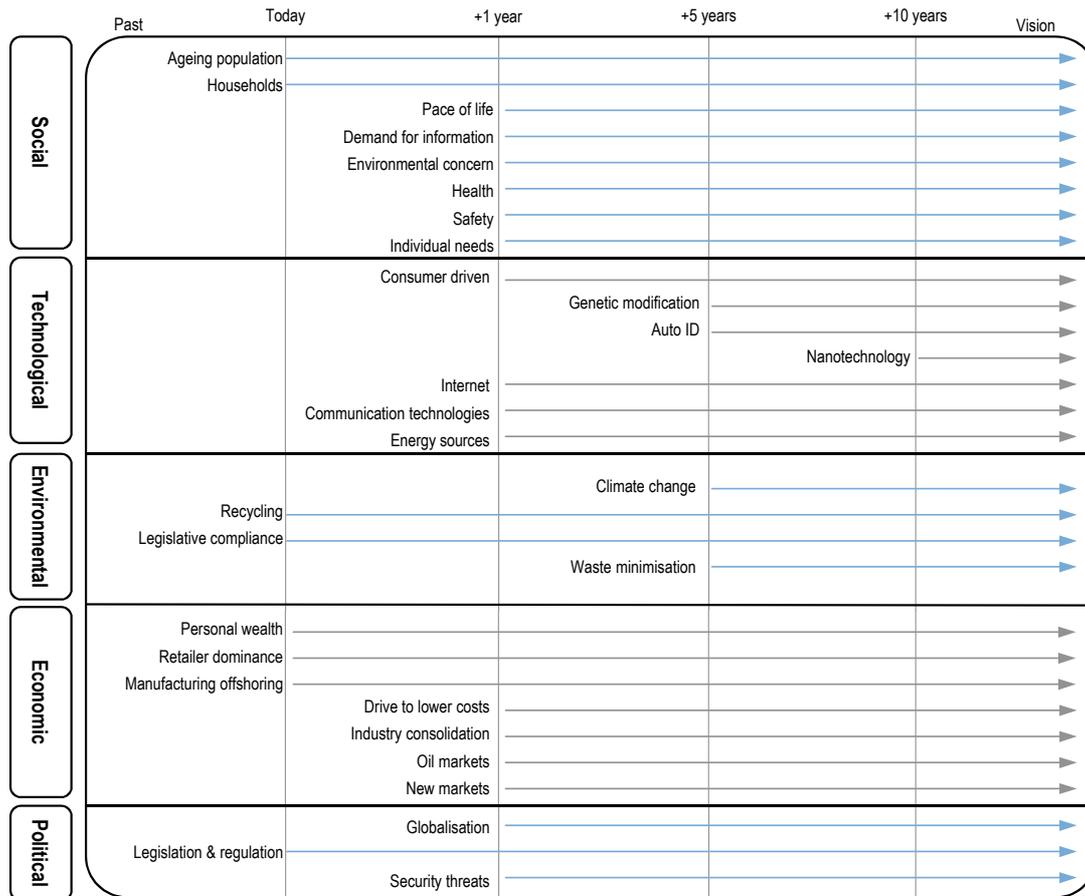


Figure 7 – Market and business headline themes

### 3.2.1 Social

This sub-layer considers the social systems in which we live, including demographics, lifestyle choices and aspirations, working patterns, and desires.

- **Ageing population:** Life expectancy is increasing and people are living longer, creating a pool of older consumers with specific requirements and needs.
- **Households:** Changes to family structures will alter the general requirements of consumers. For example there is likely to be an increase in the number of single person households, smaller families, working mothers, and children choosing to stay at home longer.
- **Pace of life:** The pace of life is increasing, with people having less free time, and spending more time outside the home.

- ***Demand for information:*** Consumers are increasingly hungry for information about the products they buy, but at the same time suffer from information overload from increasing advertising and twenty-four hour media.
- ***Environmental concern:*** The environment is not currently a priority, but concern for green issues will grow amongst consumers.
- ***Health:*** Despite problems such as increasing rates of obesity and heart disease, people are becoming more aware of their health, and will take greater care of themselves.
- ***Safety:*** There is a greater desire to feel safe, providing marketing opportunities based on a product's safety credentials. Legislative measures to protect consumers are likely to increase.
- ***Quality and luxury:*** Quality and luxury is becoming increasingly important, as consumers prioritise value over cost, and seek to buy into certain lifestyles.
- ***Individual needs:*** Consumers are more sophisticated and diverse, with expectations of greater choice and customised products to satisfy their particular needs.

### 3.2.2 Technological

This category represents how technology affects the way we live, primarily considering technologies external to the packaging sector that influence society and markets.

- ***Consumer driven:*** Technology plays a significant role in supporting lifestyles, and consumers will continue to demand products that make life more convenient and enjoyable.
- ***Internet:*** Domestic access to the internet is increasing, and the way that it is used by people will continue to evolve. This will provide new opportunities for marketing and the provision of information, and internet shopping will change the requirements of packaging.

- **Communication technologies:** Advances in communication technologies will create an increased level of ‘connectivity’, enabling people to readily access information and entertainment on the move.
- **Energy sources:** New technologies for generating energy will develop in response to increasing levels of consumption.

### 3.2.3 Environmental

This category represents considerations related to the physical environment in which we live and the associated impacts of energy production, waste, emissions and pollution.

- **Climate change:** The effects of climate change will result in more extreme and unpredictable weather.
- **Recycling:** Consumers are becoming more environmentally conscious, and legislative measures will continue to make producers and consumers take more responsibility for recycling waste.
- **Legislative compliance:** Legislative measures will continue to drive environmental improvements, making compliance an important factor in business competitiveness.
- **Pollution control:** Producers will be required to take greater responsibility for their outputs, with pollution costs tied to specific products.
- **Resource consumption:** The rate of consumption of resources will continue to increase, further depleting non-renewable resources and making them more expensive.

### 3.2.4 Economic

This category represents the influence of the financial systems that affect our lives, encompassing global, national, corporate and personal economic considerations.

- **Personal wealth:** Global development and industrialisation will continue to create wealth, but the gap between the rich and poor will also grow. The

amount of disposable income will be greatly affected by increasing consumer debt, shortfalls in pensions and changing work patterns.

- **Retailer dominance:** The size and influence of retailers will continue to grow, increasing the pressure on supply chains, and raising the market share of private label brands.
- **Manufacturing offshoring:** To remain competitive, manufacturers will continue to be pressurised into moving production to regions that offer lower costs.
- **Drive to lower costs:** Consumers will continue to demand lower costs, which will further deflate profit margins and increase commoditisation.
- **Industry consolidation:** Industry consolidation will lead to a reduction in customers and suppliers, creating fewer steps in supply chains, which will impact current alliances and partnerships.
- **Oil markets:** The cost of oil will continue to rise, making oil-based materials more expensive.
- **New markets:** The rise of new trading nations will create new customers, suppliers and competitors.

### 3.2.5 Political

This category represents the changes and influences in the systems that govern us, including: policy, regulation, legislation, and other political processes.

- **Globalisation:** Markets, businesses, services and brands will become increasingly global, producing a range of opportunities and managerial challenges.
- **Legislation & regulation:** Legislative and regulatory measures will become more extensive and ambitious, with penalties for non-compliance becoming more severe.

- **Security threats:** The threat of natural disasters, regional conflicts and terrorism will continue to loom large in the public consciousness.

### 3.3 Product Performance Headline Themes

The second broad layer of the roadmap represents the evolving requirements for packaging in five performance areas. This encompasses the functional demands on a packaged product throughout its lifecycle, as shown in Figure 8.

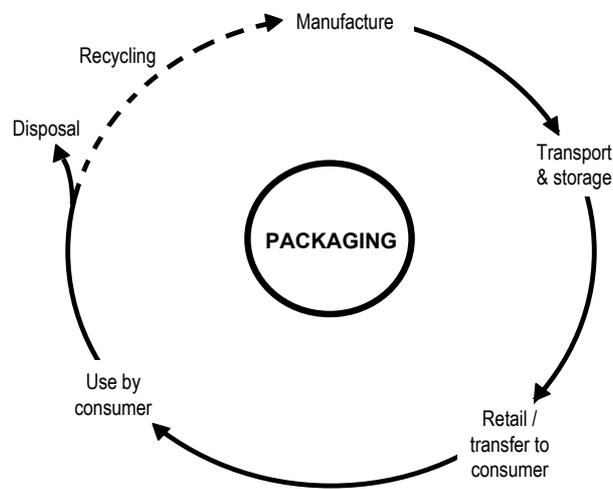


Figure 8 – The lifecycle of a packaged product

	Past	Today	+1 year	+5 years	+10 years	Vision
Recycling/ disposal			Biodegradability			
				Renewable materials		
				Waste minimisation		
			Recycling			
Use by consumer	Opening/ closing		Convenience			
			Communication			
			Safety			
			Medical compliance			
			Customisation			
			Functionality			
			Interaction with appliances			
Transfer to consumer	Efficiency gains		Security			
			Counterfeit			
		New retail channels				
		Influencing purchase/ patronage				
		Shelf-life				
Transport & storage	Product protection		Distribution costs			
			Supply chain management			
			Traceability			
Manufacture	Production		Materials			

Figure 9 – Product performance headline themes

### 3.3.1 Recycling and Disposal

This category represents the performance requirements placed on packaging at the end of a product’s lifecycle, with reference to both recycling and disposal.

- **Biodegradability:** There will be an increasing demand for biodegradable packaging.
- **Renewable materials:** The cost of non-renewable resources will rise and increase the demand for materials from renewable sources.
- **Waste minimisation:** Producer responsibility will drive waste minimisation, promoting initiatives such as lightweighting, volume reduction, and increased use of recyclable materials.
- **Recycling:** Packaging will play a key role in making products easier to recycle, and materials used in packaging will be selected on their ability to be recycled.

### 3.3.2 Use by Consumer

This category represents the specific requirements of packaging in the use of products by consumers.

- **Convenience:** The pack should make a product easier and more convenient to use or consume, by satisfying the specific demands of the consumer.
- **Communication:** Packs will be required to communicate an increasing amount of information, and to do so in more interesting and interactive ways.
- **Opening/ closing:** Consumers will reject all packaging which is difficult to open or close, increasing the demand for cost-effective closures which can be used by consumers with different abilities.
- **Safety:** Improvements in design will eliminate potential adverse effects across the entire lifecycle of a packaged product, and a significant reduction in injuries resulting from errors in using packaging.
- **Interaction with domestic appliances:** Packaging will increasingly interact with current and future generations of domestic appliances, and connectivity to home computers and the internet will become important.
- **Compliance (medical):** Packaging will play a role in ensuring that patients comply with a prescribed course of medical treatment, making it easier to take pharmaceutical products in the correct dosage and at the appropriate time.
- **Customisation:** Customisation demands that products meet the needs of different consumers, calling for packs that satisfy or adapt to the requirements of individuals.
- **Functionality:** Improvements in the functionality of packaging will enhance the experience of using products, making them easy and intuitive to use, and accommodating the different needs and abilities of consumers.

### 3.3.3 Retail/ Transfer to Consumer

This category represents the role of packaging in facilitating the sale/ transfer of goods to the consumer, and meeting other requirements of the retail environment.

- **Security:** Low-cost and reliable security devices will continue to be required to safeguard against theft, tampering and counterfeiting.
- **Counterfeiting:** Increased counterfeiting of goods will demand a range of features that make it difficult or preferably impossible to copy packaging.
- **Efficiency gains:** Packaging will facilitate efficiency gains in retailing in such areas as stocktaking, shelf-stacking and easily identifying/ locating products.
- **New retail channels:** New retail channels will continue to emerge, changing the type of products and packaging that consumers require. Technologies such as the internet, mobile phones, and digital television will change the way that consumers purchase goods.
- **Influencing purchases/ patronage:** Packaging will strive to influence purchase and patronage decisions by differentiating products from the competition, communicating with the consumer and enhancing the experience of using a product.
- **Shelf-life:** Packaging will continue to extend the shelf-life and maintain the properties of perishable goods, primarily through developments in active and intelligent packaging.

#### 3.3.4 Transport & Storage

This category represents the functional requirements of packaging in the distribution and storage of goods.

- **Reducing distribution costs:** Packaging will reduce distribution costs through minimisation of the weight and volume of packaged goods, and enabling efficiency gains in the logistics process.
- **Traceability:** The ability to track and trace products in real time will improve the management of goods in the supply chain, reduce shrinkage and safeguard against counterfeiting.

- **Product protection:** Packaging will continue to ensure the integrity and safety of products in transport and storage, with advances in protection to combat a range of different impacts and external forces.

### 3.3.5 Materials and Manufacture

This category represents the requirements associated with the raw materials and manufacturing processes that serve to create a packaged product.

- **Materials:** New materials will be developed that are more cost effective, have improved functional properties, and solve challenges specific to different products.
- **Production:** New packaging solutions will simplify production processes, improve productivity and conform to ethical and environmental requirements.

## 3.4 Technology Headline Themes

The third layer of the roadmap is concerned with the technological resources and capabilities in the packaging sector. This layer is broken into two sub-categories: products and processes.

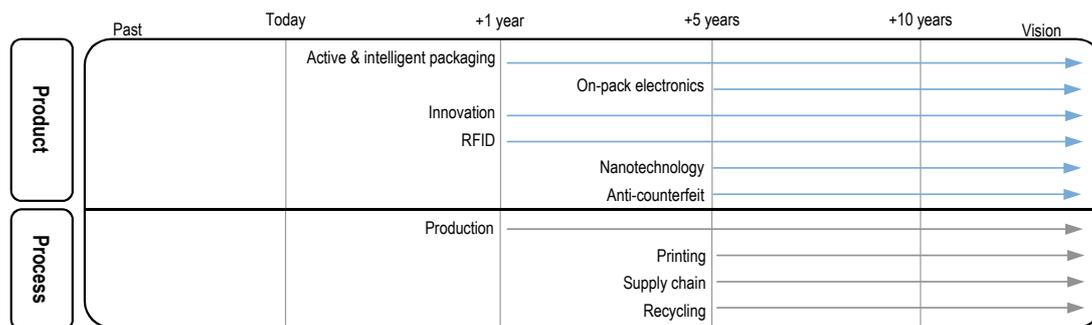


Figure 10 – Technology headline themes

### 3.4.1 Products

This category represents the technology inherent in a packaged product.

- **Active & intelligent packaging:** Active packaging will become increasingly commonplace, regulating the conditions of a packed product to prolong shelf

life and improving safety and quality. In addition, the status of the contents of the pack will be monitored and communicated by ‘intelligent’ features.

- ***On-pack electronics:*** Low-cost electronic devices will be incorporated into packaging for monitoring products, and communicating and interacting with consumers.
- ***RFID:*** Radio Frequency Identification (RFID) tags will first be applied at pallet-level, and then at item-level, with applications ranging from supply chain management, to protection against theft.
- ***Genetic modification:*** Genetic modification of packaging materials will improve functional properties and enable customisation.
- ***Nanotechnology:*** Nanotechnology in packaging will primarily be used to enhance material properties, but will also have additional applications in areas such as security.
- ***Anti-counterfeit:*** New overt and covert anti-counterfeit devices will be developed that are more difficult to copy and can be produced at a low-cost.

#### 3.4.2 Processes

This category represents the technology and capabilities inherent in the systems that serve to create a packaged product.

- ***Production:*** Minimising machine downtime, flexible capacities, easy changeovers, and consistent quality are all key objectives in the production of packaging.
- ***Machines:*** Production machinery should be easy to operate and maintain, with developments leading to increased automation and integration of machines.
- ***Printing:*** Advances in printing will impact how packaging is produced, and the technology and information that it is possible to incorporate into a packaged product.

### 3.5 Resources Headline Themes

The fourth layer of the roadmap captures the development of other resources that influence the evolution of the packaging sector (e.g. capital, skills, organisation, partnerships, supply chain etc.).

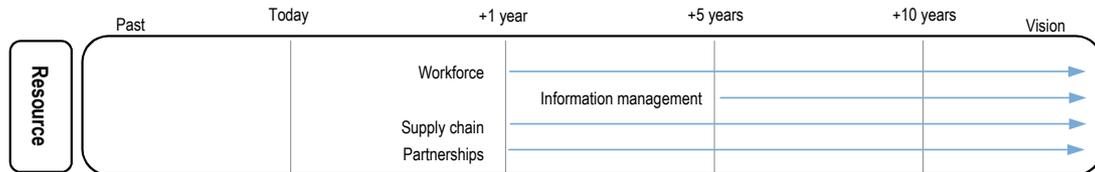


Figure 11 – Resources headline themes

- **Workforce:** More specialist skills will be required and staff will be required for global sites. However, there is a perceived problem with recruitment in packaging.
- **Information management:** New technologies such as RFID will require real-time processing and interpretation of large amounts of information.
- **Supply chain:** New technologies and systems will make it easier to communicate and share information in the supply chain.
- **Partnerships:** Strategic partnerships and industrial alliances will become increasingly important, providing access to knowledge, specialist skills, and external research and development resources.

### 3.6 Sector Priorities

The roadmapping process was used to filter out priority issues for the packaging sector, which are summarised in Figure 12. These were identified using assessment criteria developed in the roadmapping workshops. As can be seen, most of the priority themes identified were in the market and business layer of the roadmap, suggesting a strong ‘market-pull’ bias in the sector.

Market & business themes	Product performance themes	Technology themes	Resource themes
<ul style="list-style-type: none"> <li>• Ageing population</li> <li>• Changing household structures</li> <li>• Increasing demand for information</li> <li>• Convenience</li> <li>• Needs of the individual</li> <li>• Health</li> <li>• Safety</li> <li>• Environmental concern</li> <li>• Internet-related opportunities</li> <li>• Increasing regulation</li> <li>• Opportunities in new markets</li> <li>• Drive to lower costs</li> <li>• Manufacturing offshoring</li> </ul>	<ul style="list-style-type: none"> <li>• Waste minimisation</li> <li>• Recycling</li> <li>• Biodegradability</li> <li>• Opening/ closing</li> <li>• Convenience in use</li> <li>• New retail channels</li> <li>• Counterfeiting</li> <li>• Traceability</li> <li>• Materials</li> </ul>	<ul style="list-style-type: none"> <li>• RFID</li> <li>• Nanotechnology</li> <li>• Intelligent packaging</li> <li>• Advances in production</li> </ul>	<ul style="list-style-type: none"> <li>• Partnerships</li> </ul>

Figure 12 – Priority themes identified in the roadmapping workshops

## 4 Discussion

The packaging sector is made up of a diverse array of organisations that face an extensive range of competitive challenges and opportunities. Although the specific mix of these challenges and opportunities will be unique to individual companies and markets, there are some common factors that will affect the sector as a whole.

In order to obtain a better understanding of these factors, the data collection phase of this research specifically sought to gain insights from organisations across supply chains, materials sectors, different markets and geographical regions. Additional insights were also provided by academics to further complement the range of perspectives.

The common factors to emerge from these consultations were used to develop the headline themes presented in this report. This provides an extensive list of the key trends and drivers facing the packaging sector over the next ten years. This list should not be considered exhaustive, as there will undoubtedly be additional factors that will influence the development of the sector.

The report is presented as a roadmap, with the trends and drivers structured into the broad layers and sub-layers of a prescribed architecture. This enables clear communication of the key market, technology, product and resource developments facing the packaging sector, with the sub-layers of the roadmap offering further categorisation, placing the trends and drivers in a defined context. The roadmap architecture also quantifies the time horizons in which the trends and drivers are believed to be of importance.

It is important to recognise that the categorisations developed to communicate the headline themes will change over time and will also influence other trends and drivers identified in the roadmap. Therefore the individual headline themes and layers of the roadmap should not be considered in isolation, as the linkages between them are extremely important in assessing the likely implications of these developments.

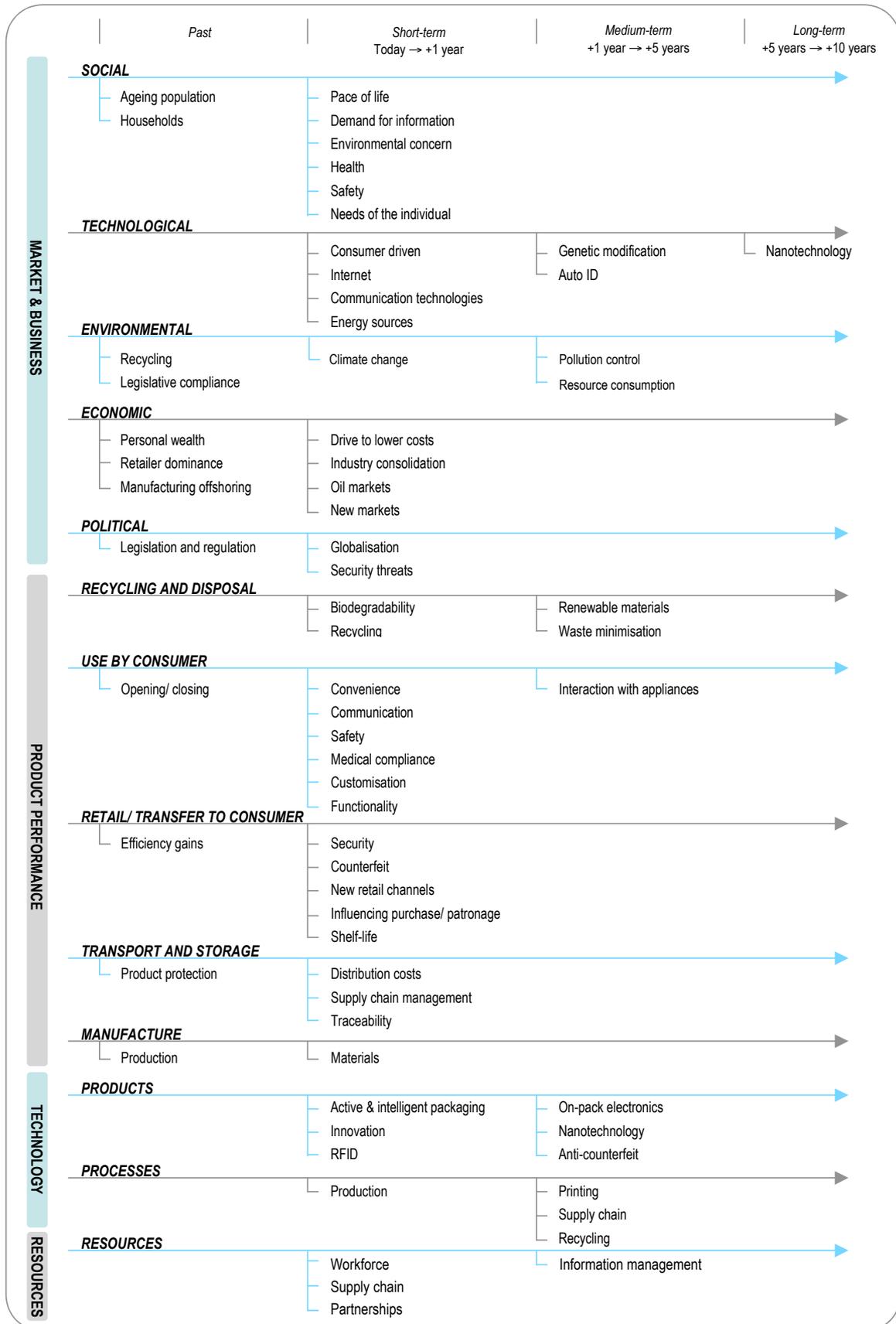
A number of important linkages between trends and drivers are presented in the detailed insights in the Appendices of the report. These insights provide further clarification on the nature and implications of each of the trends and drivers, highlighting the range of issues that were identified in the roadmapping workshops.

A key motivation behind the development of the roadmap was to provide a resource to stimulate thought and discussion in the sector. This stems from an awareness that the diverse nature of the industry means that the implications of the trends and drivers will vary considerably between different companies, markets and geographical regions. Hence the report consciously avoids interpretation of the insights collected.

The roadmap is intended to be a resource that provides useful information, structure and context for strategic planning and innovation processes in the packaging sector. It presents a complex 'landscape' of trends and drivers through which companies and supply chains will be required to navigate. The path that companies and sector-level organisations choose to take through this landscape will depend on individual priorities. However, it is hoped that through identification of a range of factors that are common to a variety of markets and products, the roadmap represents an initial step in developing a sector-wide response to meeting some of these key challenges and opportunities.

# Appendix

# High-Level Roadmap

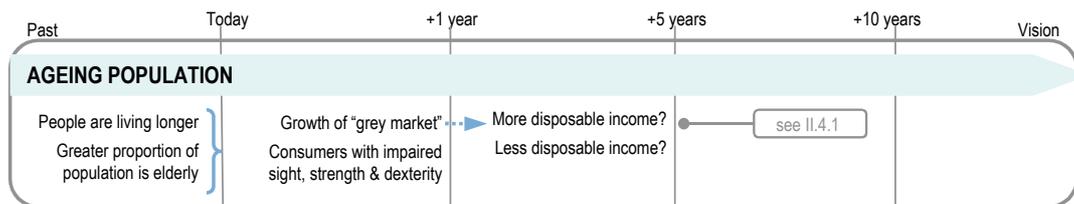


# II. Market and Business Insights

## II.1. Social

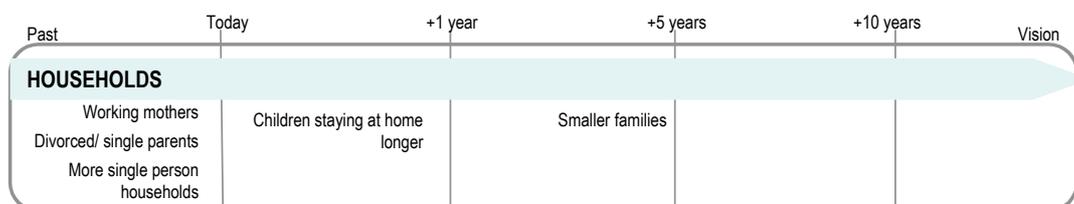
### II.1.1. Ageing Population

The average life expectancy has increased in the developed world and an increasing proportion of the population is elderly. This has led to a growth in the ‘grey market’, with a growing requirement for products that cater for the needs of these individuals. There is some question over whether the implication of this will be that consumers have an increased or decreased disposable income.



### II.1.2. Households

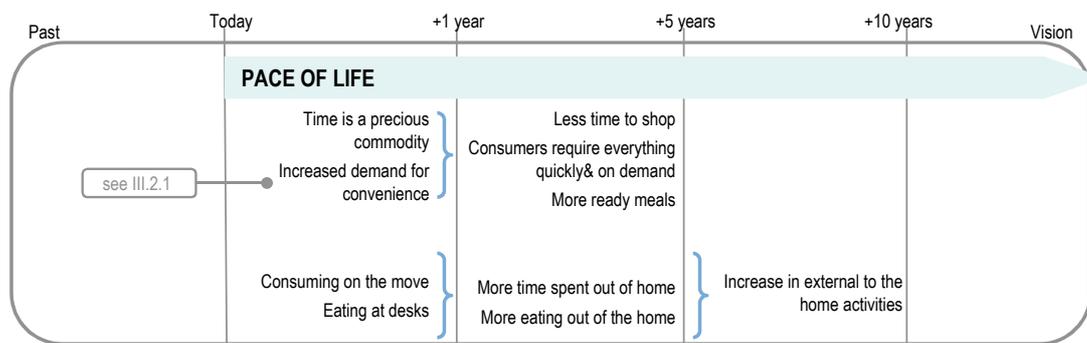
The increase in single person households and changing family structures is likely to affect the general requirements of consumers. Specific changes in family structures are: the greater tendency for mothers to pursue a career, an increase in divorced and single parents, children staying at home longer, and smaller families.



### II.1.3. Pace of Life

Time has become a precious commodity and this has increased the demand for convenience. As a result of hectic lifestyles people have less time to shop and prepare meals. This creates a demand for convenience products such as ‘ready meals’. A further aspect of this ‘time crunch’ is that consumers expect things as quickly as possible, and whenever they need them.

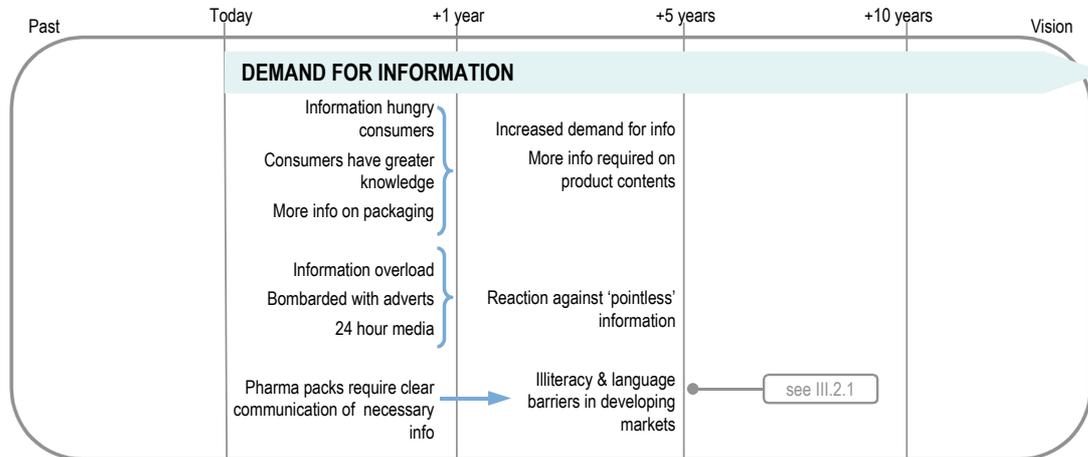
A specific trend is that more products are consumed outside of the home. For example, food and drink are increasingly eaten outside of the home, such as at desks, on the move, and in restaurants. In the future it is believed that people will spend less time in their homes, and there will be a consequent rise in external to the home activities.



### II.1.4. Demand for Information

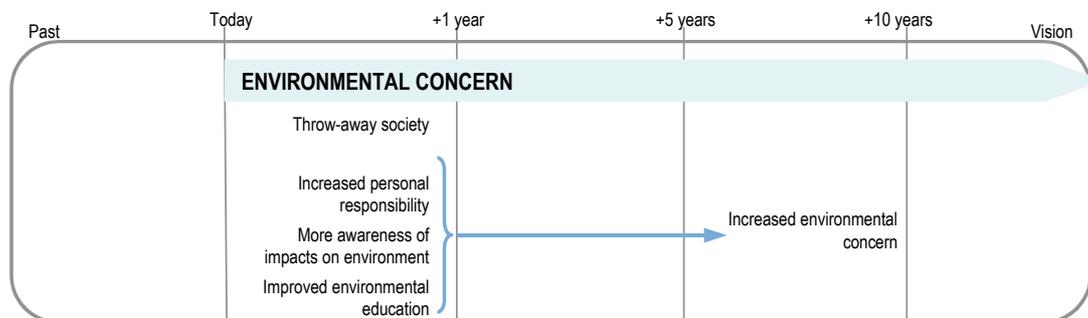
Consumers have a greater desire for information about the products that they buy, and this is likely to increase in the near future. This can be linked to the fact that consumers have a greater general awareness of important issues associated with certain products and hence require more information on packaging. However, this is set against a backdrop of continuous bombardment by advertising messages, and twenty-four hour media. This may affect the way that people absorb information, and lead to a state of ‘information overload’ where consumers react against unwanted messages.

Clear and effective communication of information is currently an important requirement for pharmaceutical products. A specific consideration is how this information can be provided in a way that overcomes illiteracy and language barriers that may be present in developing markets.



### II.1.5. Environmental Concern

We live in a ‘throw-away’ society with little concern for the environment. However, it is believed that people are becoming more aware of the environmental impacts of their actions, and are taking on board a degree of personal responsibility for these activities. This is linked to a general improvement in the level of education of consumers in relation to environmental matters, and will result in a growing level of concern.



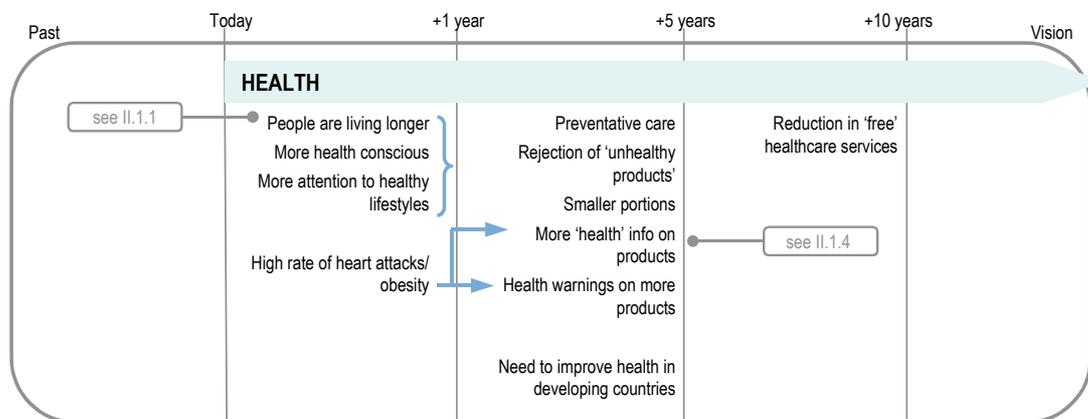
### II.1.6. Health

The average life expectancy today is greater than for previous generations. The general population is more health conscious and more inclined to pay attention to leading a healthy lifestyle. This includes consumers taking such actions as ‘preventative care’ by rejecting ‘unhealthy products’, consuming smaller portions, and requiring more health and nutritional information on packs.

However, despite this, there are high rates of obesity and heart disease in the developed world. This could be a further driver for more information, and may lead to health warnings being placed on certain products.

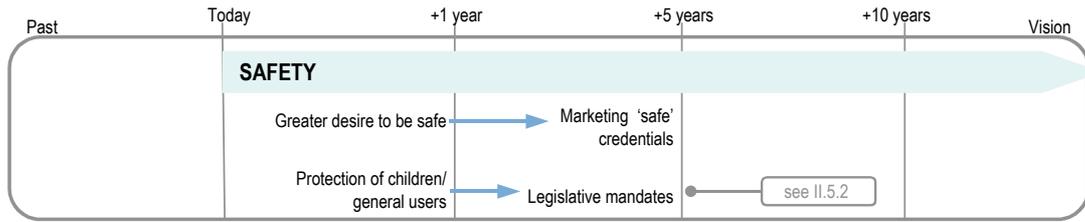
There is a growing consensus that efforts need to be made to improve the health of citizens of developing countries.

The attitudes of consumers towards health issues may also be affected by a likely reduction in the availability of ‘free’ or subsidised healthcare, as a result of an increasingly elderly and unhealthy population.



### II.1.7. Safety

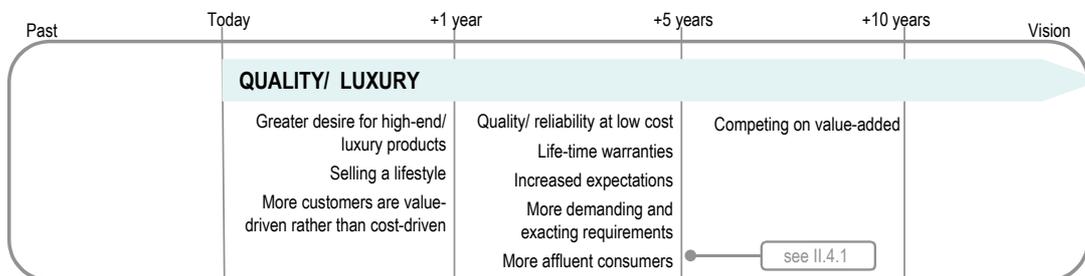
There is a perceived desire amongst consumers to ‘feel safe’ and this could present opportunities for marketing products on the basis of their safety credentials. Legislative measures are currently in place to protect consumers, and in particular children. These controls are likely to become more strict and extensive in the future.



### II.1.8. Quality/ Luxury

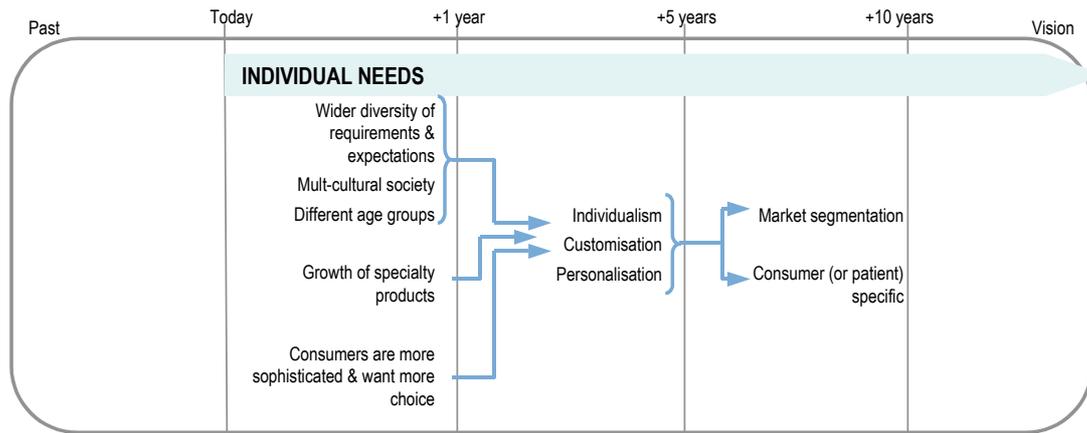
There is an increased demand for high-end and luxury products, which are seen to 'sell a certain lifestyle' and it is perceived that there are a greater number of 'more affluent' consumers.

However it is also believed that there is a greater number of customers who are value-driven as opposed to cost-driven. In general, consumers will have increasingly demanding expectations and exacting requirements, such as lifetime warranties for products. It is believed that there are a number of opportunities across the packaging sector to compete on the basis of added value.



### II.1.9. Individual Needs

There is a greater diversity of requirements and expectations among consumers. We live in multi-cultural societies, where the requirements of different age groups are being recognised. Consumers are more sophisticated and demand more choice, which has resulted in a growth in specialty products. Recognising the needs of individuals, enabling the personalisation of products, and customising products for different users are all important tenets of this trend. This is likely to be achieved by more accurate segmentation of different consumer groups, or by targeting products at individual consumers.

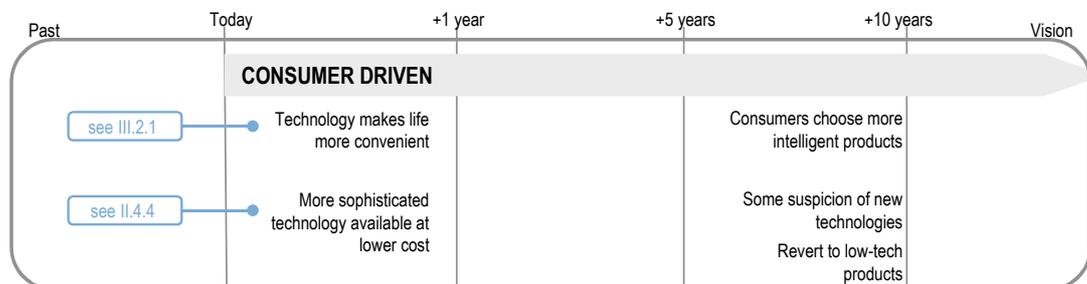


## II.2. Technological

### II.2.1. Consumer Driven

Consumers embrace technology because it invariably makes life easier or more enjoyable in some respect. The rate of technological development has been such that more sophisticated products are available at a lower cost to consumers, making these items even more desirable.

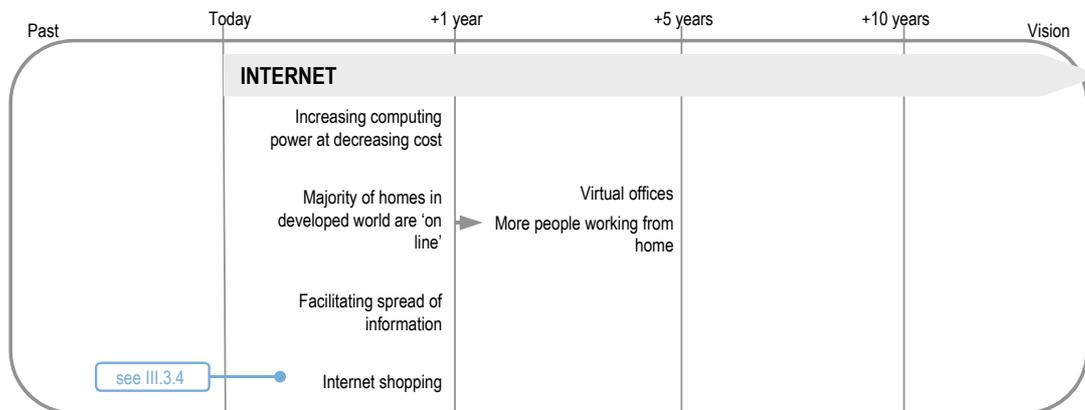
In the future consumers may differentiate between products on the basis of which is more technologically advanced or ‘intelligent’. However, it should also be considered that there may be some suspicion associated with certain products, that could lead to a reversion to low-technology products.



### II.2.2. Internet

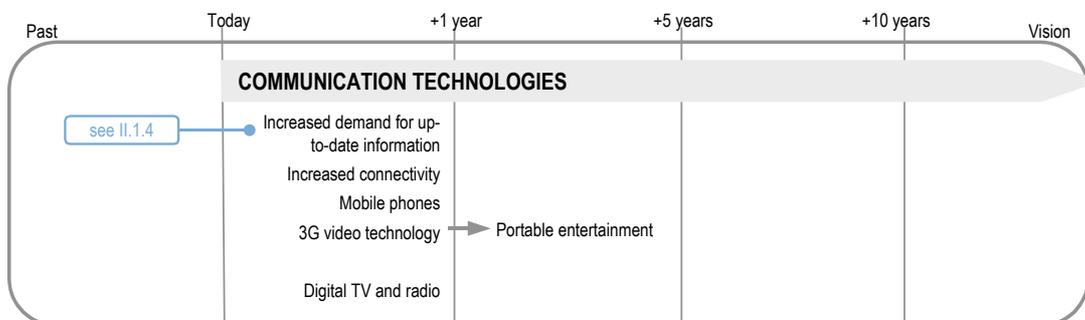
The evolution of the home computer has seen increasing power become available at decreasing cost. This has provided the majority of people in the developed world with easy access to the internet, which has enabled specific applications such as ‘virtual offices’ and the ability to work from home.

The internet is seen as a powerful medium for spreading information around the world, and has become increasingly popular as a portal for shopping.



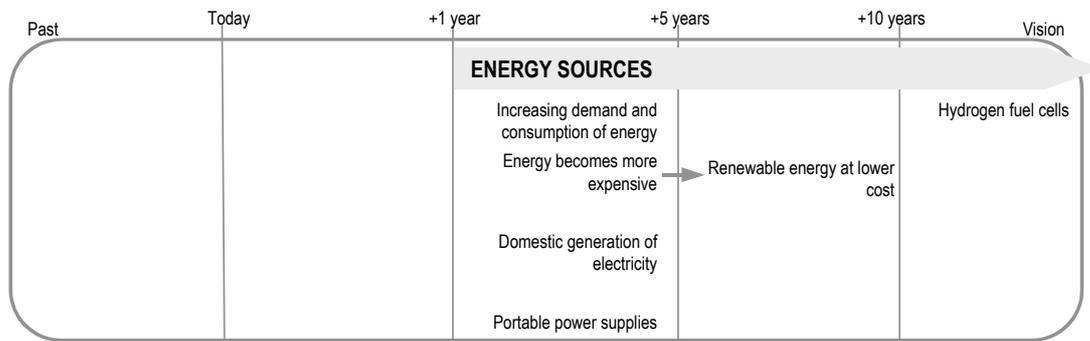
### II.2.3. Communication Technologies

We live in a society that has an increasing thirst for up-to-date information. The proliferation of mobile phones means that we are more ‘connected’. ‘3G’ video technology brings a new dimension in portable entertainment. Digital television and radio is also changing how we receive and interact with the media.



### II.2.4. Energy Sources

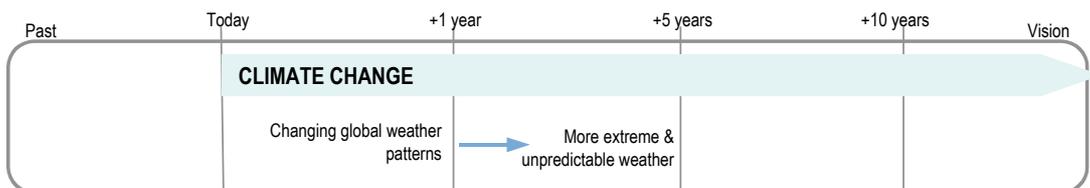
Development has brought about increased demand and consumption of energy. As energy becomes more expensive, consumers will look for cheaper alternatives, such as home generation of electricity, and low-cost renewable sources. In the future, hydrogen fuel cells could have a significant impact on existing technologies.



## II.3. Environmental

### II.3.1. Climate Change

The world is experiencing changing global weather patterns. This results in more extreme and unpredictable weather.

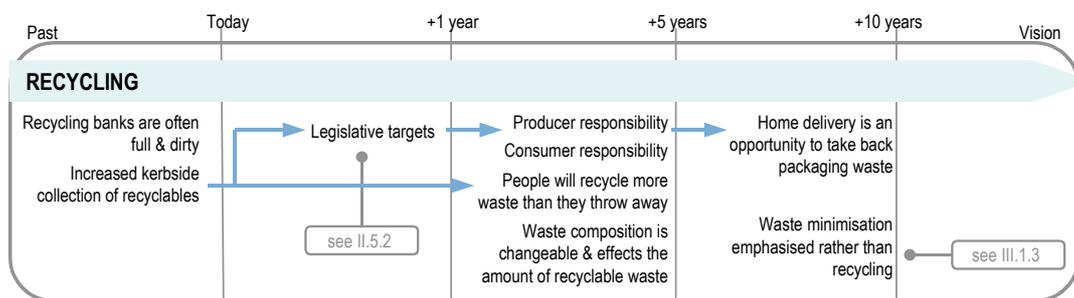


### II.3.2. Recycling

The banks at recycling points or ‘bring sites’ are often full and dirty which has an effect on the public’s decision to use these facilities. However, recycling of domestic waste has been made easier by increased kerbside collection of recyclables in certain countries. This is primarily being driven by legislative targets, which are likely to be further extended so that producers and consumers have to take more responsibility for

recycling certain waste products. The increase in home delivery of goods, primarily as a result of internet shopping, is seen as an opportunity for ‘producers’ to take back the waste products for which they have a responsibility.

It is anticipated that the proportion of domestic waste that is recycled will increase, with eventually more waste being recycled than is thrown away. However, it needs to be recognised that waste streams are dynamic and changeable, which will affect the amount of waste that can be recycled. It is also important to emphasise waste minimisation over recycling, as this is a preferable option.

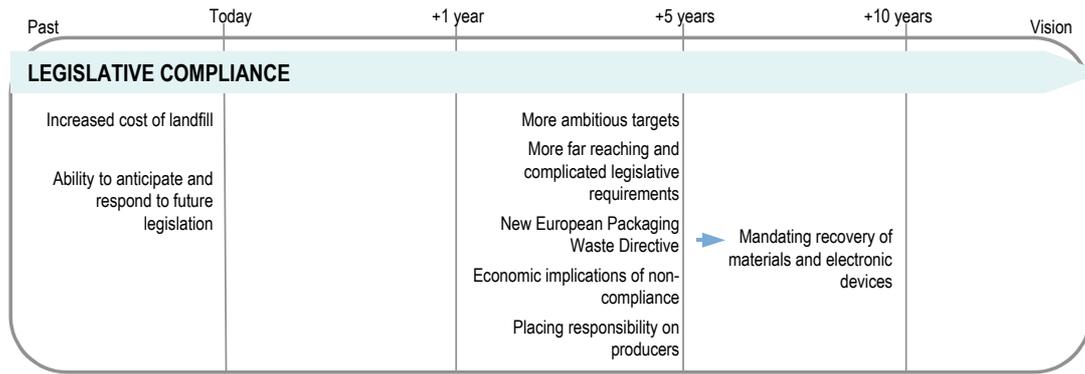


### II.3.3. Legislative Compliance

Environmental measures are often driven by the need to comply with legislative requirements. This can have a considerable effect on how environmental considerations are managed. For example, landfill has become a less attractive option for waste disposal in certain countries, primarily as a result of fiscal measures that have made it considerably more expensive.

The ability to anticipate and respond to future environmental legislation is seen as a key competitive issue. This is likely to be given a greater emphasis when more ambitious, far-reaching and complicated legislation is introduced to protect the environment. This is likely to place a greater responsibility on ‘producers’ of environmental burdens, and increase the financial cost of non-compliance.

A packaging specific issue will be the introduction of a new European Packaging Waste Directive, which it is believed may mandate recovery of certain materials from the waste stream, and perhaps incorporate separation of electronic devices, such as RFID tags.

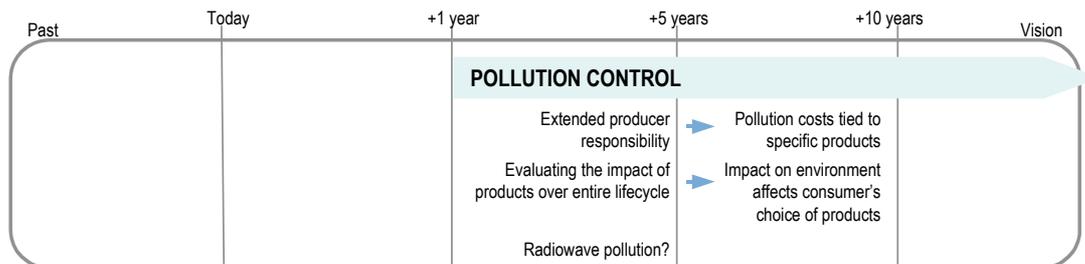


### 11.3.4. Pollution Control

A key measure that will prevent pollution will be the introduction of policies and measures to extend the responsibility of producers for the environmental impacts of their products. This will extend across the entire lifecycle of a product, and raise specific obligations for their take-back, recycling and disposal.

This increased awareness of the impact of products throughout their lifecycle may affect consumer’s choices when it comes to selecting goods.

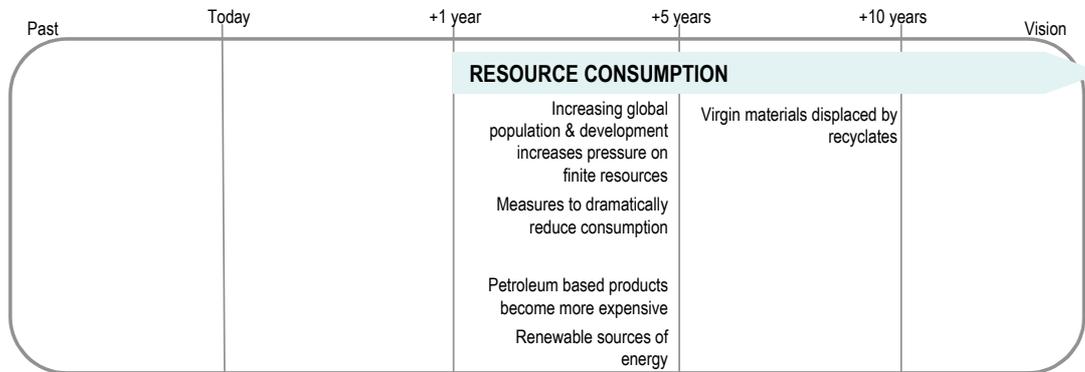
A further consideration that was identified was radiowave pollution, and how the risks of this to human health are not properly understood.



### 11.3.5. Resource Consumption

The increasing global population has resulted in an increase in resource consumption and placed greater pressure on finite supplies of such materials as fossil fuels. It is likely that this will result in materials such as petroleum-based products becoming more expensive. This may lead to an increased use of recycled material, and a decrease in the amount of virgin materials consumed.

The increased cost of finite resources may also encourage the use of alternative forms of energy production.



## 11.4. Economic

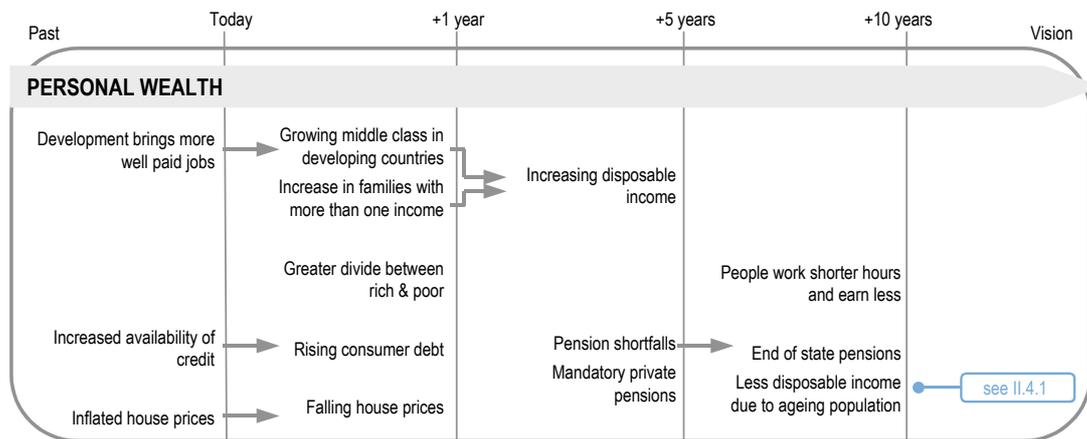
### 11.4.1. Personal Wealth

Development and industrialisation have created wealth. Contributing factors as to why some consumers have greater disposable incomes include rapidly growing middle classes in developing countries as a result of new employment opportunities, and a rise in the number of families where both parents are earning a wage. There remains, however, a substantial divide between the ‘rich’ and the ‘poor’ and this is seen to be increasing.

There are high-levels of debt amongst consumers, which can be partially attributed to the increased availability of credit. Inflated house prices are seen to have given people an artificial sense of wealth, and there is a real possibility that this market may collapse and increase the debt burden on consumers.

Shortfalls in pension plans are also a big concern. As a result of the ‘ageing population’ the burden on employers and the state is set to increase, and individuals are facing the prospect of a less secure retirement. This could culminate in an end to state pensions in certain countries, and a mandatory requirement to subscribe to private plans. As a result of this, consumers would have less disposable income.

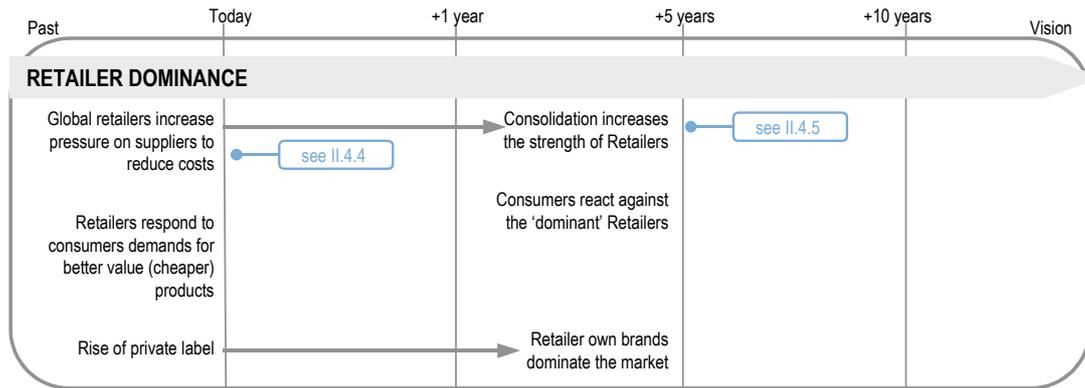
A change in people’s attitude to work might also be likely. Quality of life might take precedence over income, where individuals and families merely work to live rather than live to work. This may result in a decrease in the number of hours that people work, and a decrease in the amount of their disposable income, but an increase in the amount of recreational time that they have available.



### II.4.2. Retailer Dominance

A number of ‘Retailers’ have become powerful global companies. It is possible that the size and influence of these companies will grow as a result of mergers and acquisitions within the retail industry. This status enables Retailers to exert considerable pressure on the supply chain, in particular to make efficiency gains and to reduce costs. It can be argued that Retailers are simply responding to the demands of consumers to have better value and ‘cheaper’ products. However, there is a possibility that consumers may react against these powerful companies and take their custom elsewhere.

Another area in which Retailers have made an impact is the rise of private label and the impact that this has had on ‘branded goods’. It is possible that this may grow to a level where Retailers’ brands dominate the market.

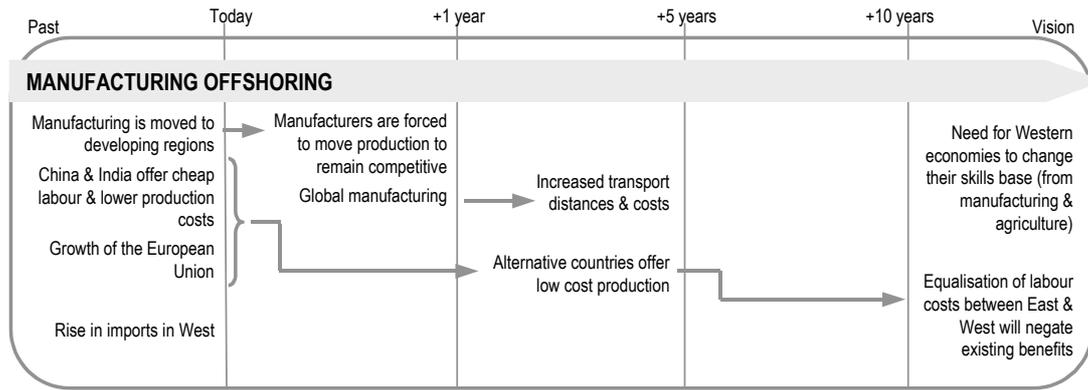


### II.4.3. Manufacturing Offshoring

Offshoring is the movement of manufacturing to developing regions. This is often because countries such as China and India offer cheap labour and lower production costs, so companies are forced to move their manufacturing operations to such areas to remain competitive.

This has created a global business culture, with increased transport distances and costs, and new managerial challenges. Overall, there is a rising quantity of imports into the 'West' and there may be a long-term requirement for 'Western' economies to change their skills base from manufacturing and agriculture to areas where they can be more competitive.

In addition to China and India, the expansion of the European Union has provided new opportunities for overseas production. It is likely that a number of other countries will also become major players in terms of offering low-cost production. This may eventually lead to an equalisation of labour costs between these countries and the 'West', which would impact on their ability to offer such low production costs.

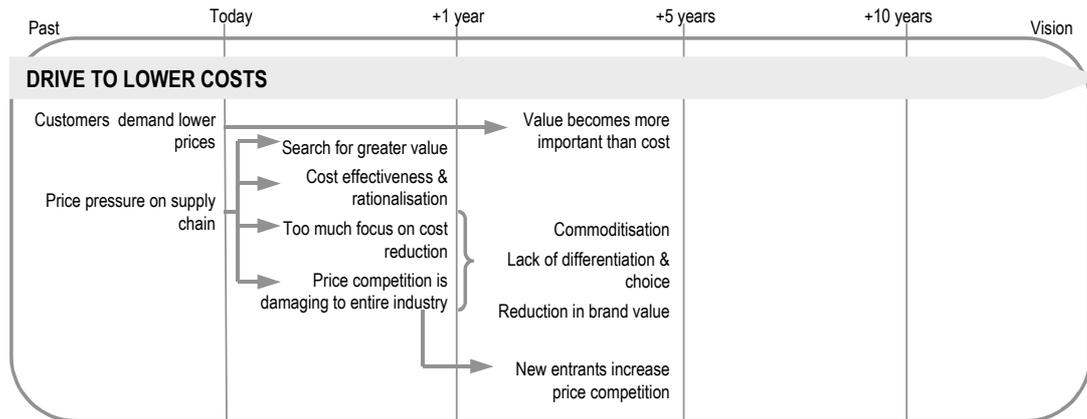


#### II.4.4. Drive to Lower Costs

Right across supply chains and through to the end-user, customers are demanding lower prices. This places a considerable amount of price pressure on the supply chain. There is a strong emphasis on cost reduction, cost effectiveness and rationalisation. This type of competition is seen to be damaging to the entire industry, and could possibly be made worse by new entrants offering even lower prices.

The main problem is that price reduction can lead to commoditisation, a lack of differentiation and a reduction in brand values. Consequently, customers will have less choice.

In reaction to this, a new form of competition may emerge whereby a greater emphasis is placed on value than cost. This would mean that companies attempt to deliver higher-value products and services, competing on the basis of such factors as their ability to 'innovate' and to respond to a customer's needs.



#### 11.4.5. Industry Consolidation

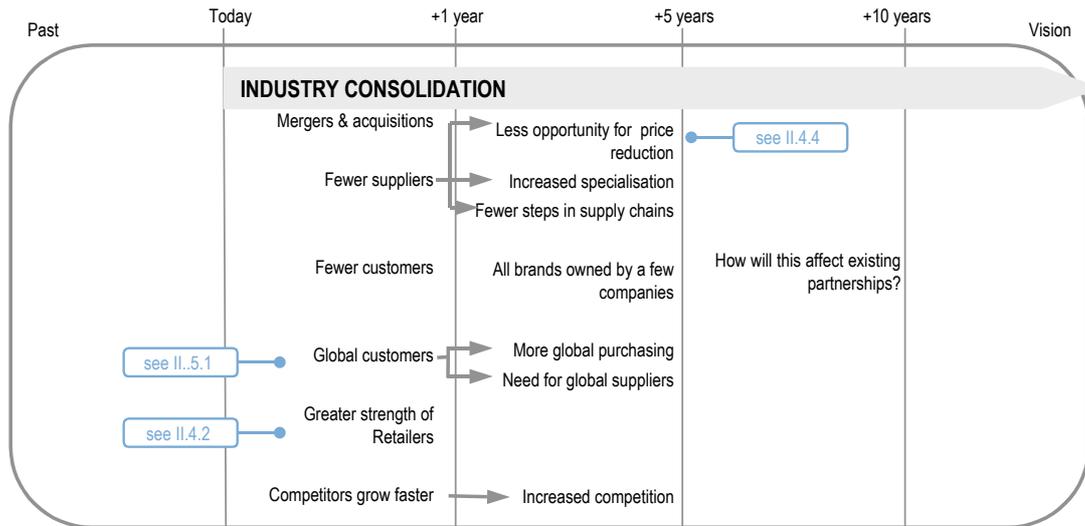
There is a perceived trend towards consolidation in the industry, with an increase in mergers and acquisitions.

An implication of this would be fewer suppliers. This could result in there being fewer steps in the supply chain, fewer opportunities for price reduction, and an increase in ‘specialist suppliers’.

A decrease in industrial customers could result in all brands being owned by a few companies. It could place an emphasis on the need to do business on a global scale, which may encourage the growth of global suppliers, to service the requirements of these customers.

Consolidation may be a means of increasing the strength of Retailers. It may also lead to increased competition across the supply chain by enabling competitors to grow rapidly.

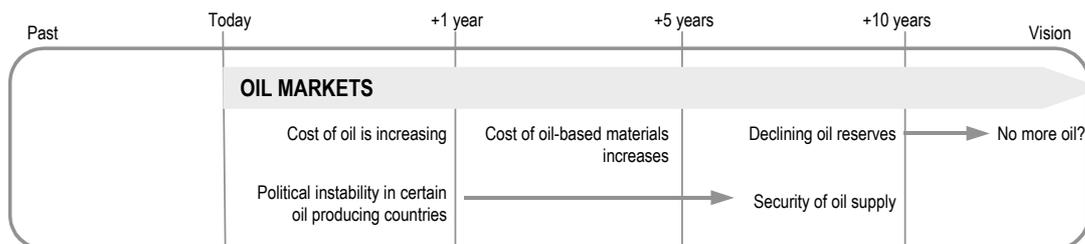
A key question underpinning all of these possibilities is ‘what are the implications of these changes for existing relationships between companies?’



### II.4.6. Oil Markets

The cost of oil is increasing, and will lead to a subsequent increase in the cost of certain oil-based materials, such as plastics, resins and chemicals. This is likely to become of greater significance as oil reserves are further depleted in the future, and may lead to a requirement to replace all products that use oil.

Another problem that may affect the price of oil is the perceived political instability in certain oil-producing countries. This may seriously affect the security of oil supply.



### II.4.7. New Markets

There has been a rise of new trading nations, such as China, India, Brazil Russia and Eastern Europe. This creates the potential for new customers and suppliers, but could also produce new competitors.

Serving these markets may require new products and business approaches. The increase in competition may also increase the requirement to differentiate and protect valuable brands.



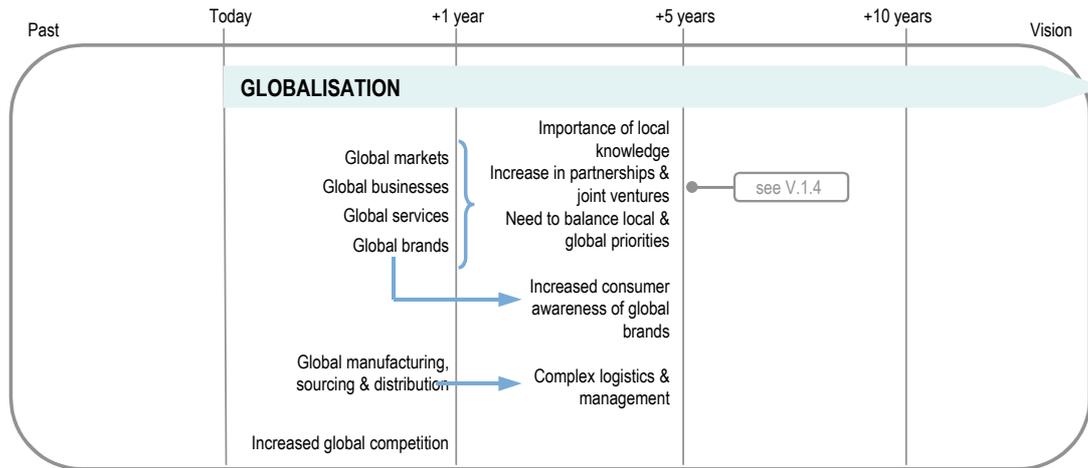
## II.5. Political

### II.5.1. Globalisation

Markets, businesses, services and brands are all becoming increasingly global. To compete in this global arena often requires a good knowledge of local markets, which is one area where partnerships and joint ventures can make an important contribution. Overall there is a perceived need for companies to be able to balance local and global priorities.

These global operations raise complex managerial challenges in administering global manufacturing, sourcing and distribution. They also could result in increased competition from new entrants.

The globalisation of brands invariably leads to increased consumer awareness of certain products. This may deliver or secure a market-leading position, or it could dissuade consumers from patronising certain products.

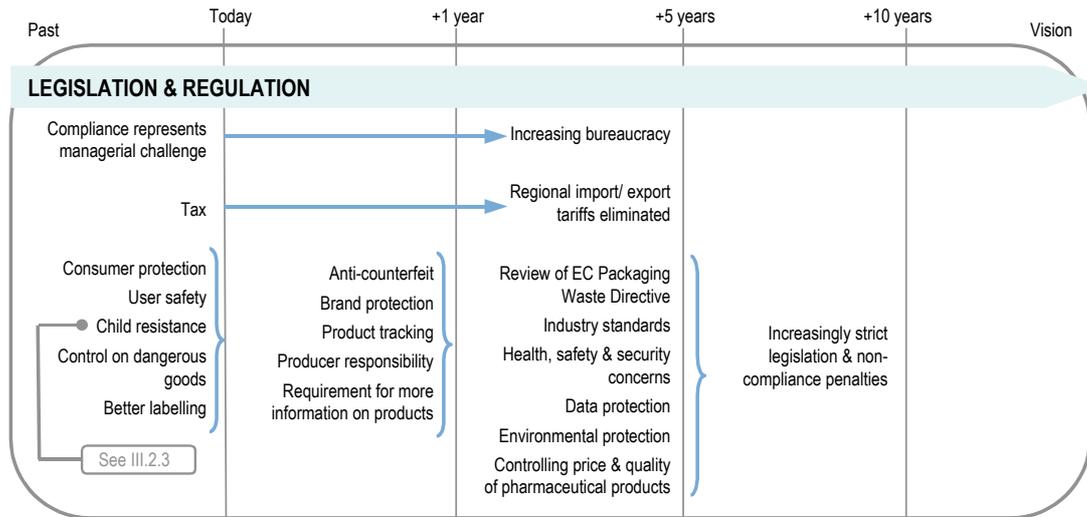


### 11.5.2. Legislation and Regulation

Compliance with legislative and regulatory measures represents a complex managerial challenge. This is set to increase as these measures become more intricate, and is likely to result in an increase in bureaucracy.

An area that is seen to have a major impact on business is tax. A specific change to this area that may take place would be the elimination of regional import and export tariffs.

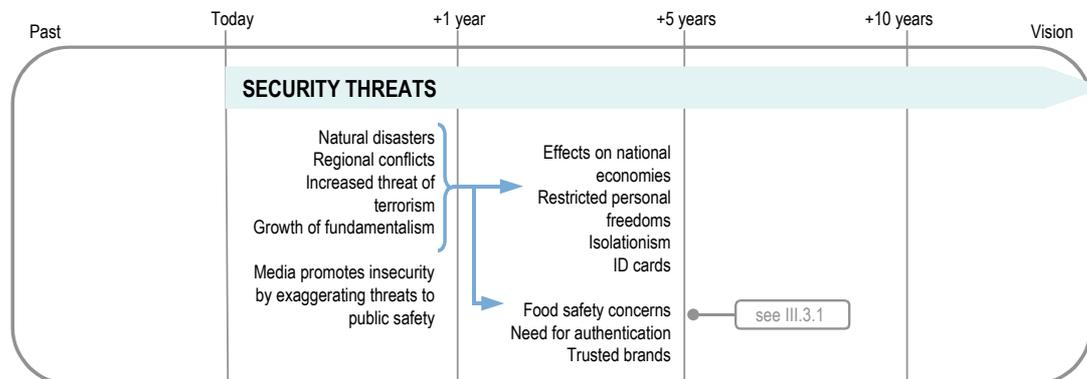
A number of specific areas where new legislative controls are likely are identified. In each of these areas, the measures are expected to become increasingly strict, and penalties for non-compliance will be more severe.



### II.5.3. Security Threats

There is a general sense of insecurity in modern society in the face of natural disasters, regional conflicts, and an escalation in terrorist activity. These concerns are believed to be greatly influenced by the media, which is seen to exaggerate the actual threat to public safety.

The implications of these threats are such issues as: possible damage to national economies, restricted personal freedom, and increased isolationism in global politics. Matters such as concerns over food safety may promote such requirements as the need for authentication, and increase the importance of having a ‘trusted brand’.



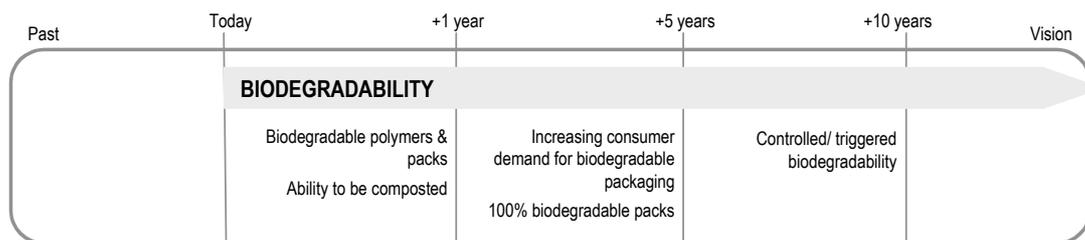
# III. Product Performance Insights

## III.1. Recycling and Disposal

### III.1.1. Biodegradability

There will be an increasing demand for biodegradable packaging, which will require biodegradable polymers and packs. The ability to be composted or to degrade over time may influence the selection of materials.

It may be desirable for packaging to have ‘controlled’ or ‘triggered’ biodegradability to ensure that the packs do not degrade before they are supposed to.

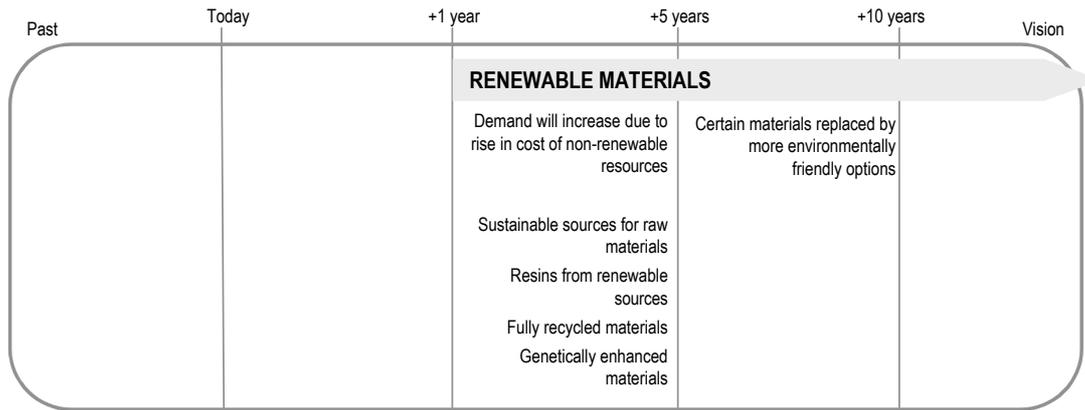


### III.1.2. Renewable Materials

The rise in the cost of non-renewable resources will increase the demand for materials and resins from renewable sources. The environmental benefits of these materials will also encourage their use.

It is possible that the genetic modification of material sources may deliver renewable materials with the required properties and performance for different applications.

The ability to have 100% material recovery from packaging is also a desirable objective.



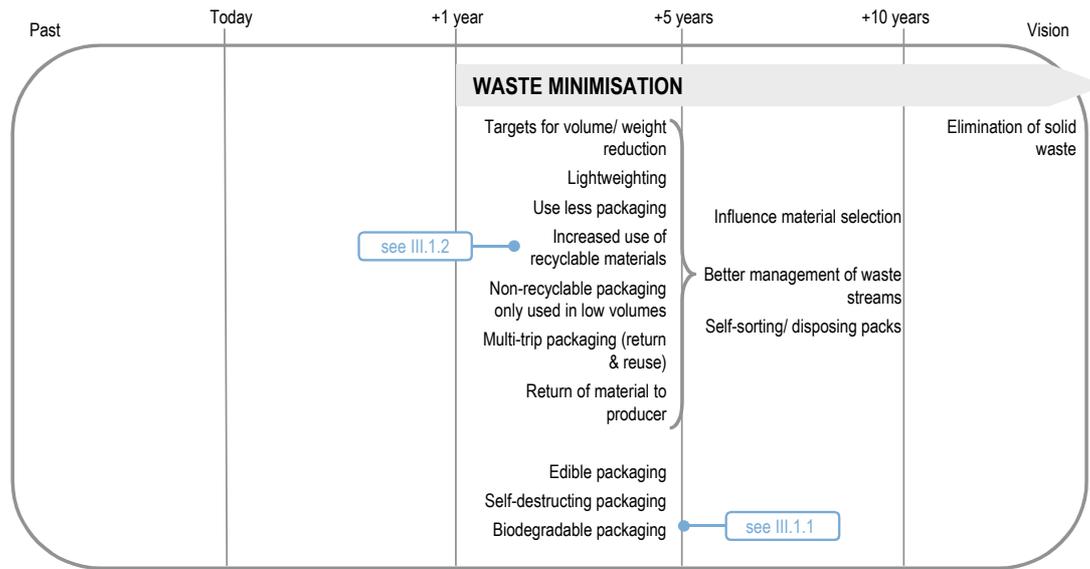
### III.1.3. Waste Minimisation

Waste minimisation is likely to be driven by legislative targets. This will promote such initiatives as: lightweighting, volume reduction, and increased use of recyclable materials. Producer responsibility may require companies to ‘take back’ waste from the consumer. This could lead to a growth in multi-trip or reusable packaging.

All of these considerations are likely to influence material selection in the design of packaging products, and will require better management of waste streams.

Specific material properties may contribute to waste minimisation, such as edible, biodegradable, self-destructing or self-sorting packaging.

Overall, the objective of this trend will be to work towards a state of ‘zero waste’ production.

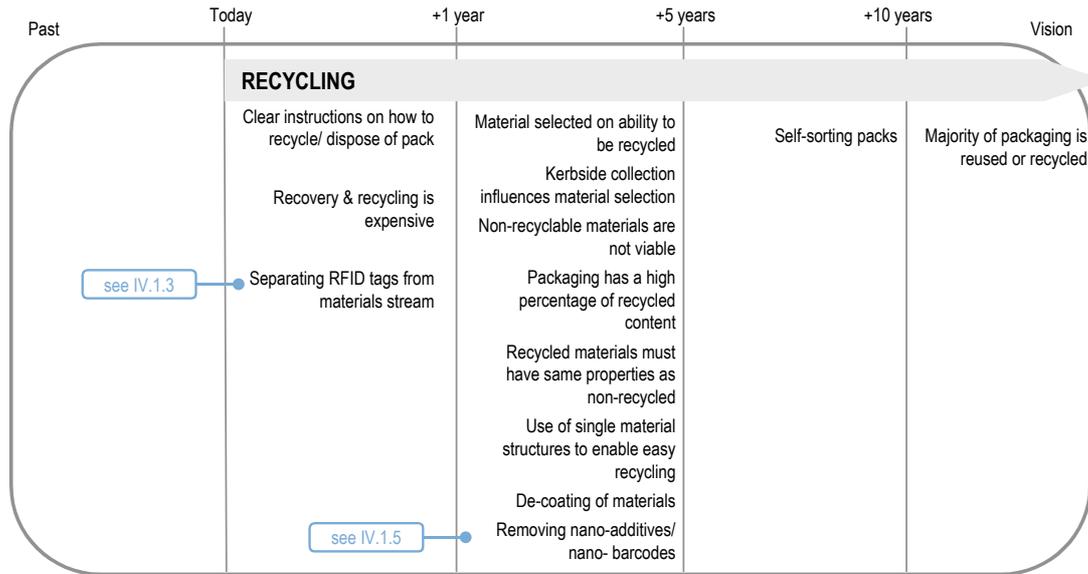


### III.1.4. Recycling

Packaging can potentially play a major role in facilitating and improving recycling efforts. A simple example of this is by communicating clear instructions on how a pack or product should be disposed of or recycled. Packaging may also be able to make the process of recycling more efficient and less expensive. For example, self-sorting packs that separate themselves from a general waste stream. This may lead to the majority of packaging being reused or recycled.

As recycling becomes more important, it may have an effect on the choice of packaging materials and products. For example, materials will be selected on their ability to be recycled, or the ease with which they can be recycled. Whether or not the materials can be taken in kerbside collection schemes may also influence this choice. Ultimately this may lead to a situation where materials that are not recyclable will simply not be viable.

Potential challenges in relation to the recycling of packaging will be factors such as: the separation of RFID tags from packaging; removing nano-additives and nano-barcodes; de-coating materials; and separating composite materials. A key objective will be to ensure that recycled materials, and materials that have a high recycled content have the same or better properties than alternative materials.

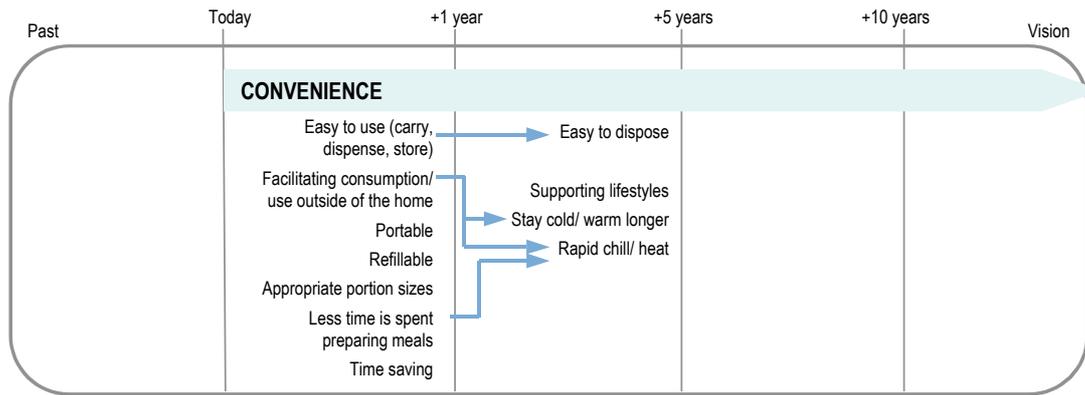


## III.2. Use by Consumer

### III.2.1. Convenience

Packaging should make products more convenient for consumers to use. This encompasses considerations such as carrying, opening/ closing, dispensing, storing and disposing. Packaging can also make products more convenient for consumers by delivering appropriate portion sizes, and reducing the time and effort associated with using a product, such as reducing the time that it takes to prepare a meal.

The pack should also support various lifestyle requirements such as enabling easy consumption outside the home. This demands specific properties such as portability, and in the case of food products, a number of additional functions may be desirable, such as thermal insulation, rapid chill/ heat, and the ability to refill.



### III.2.2. Communication

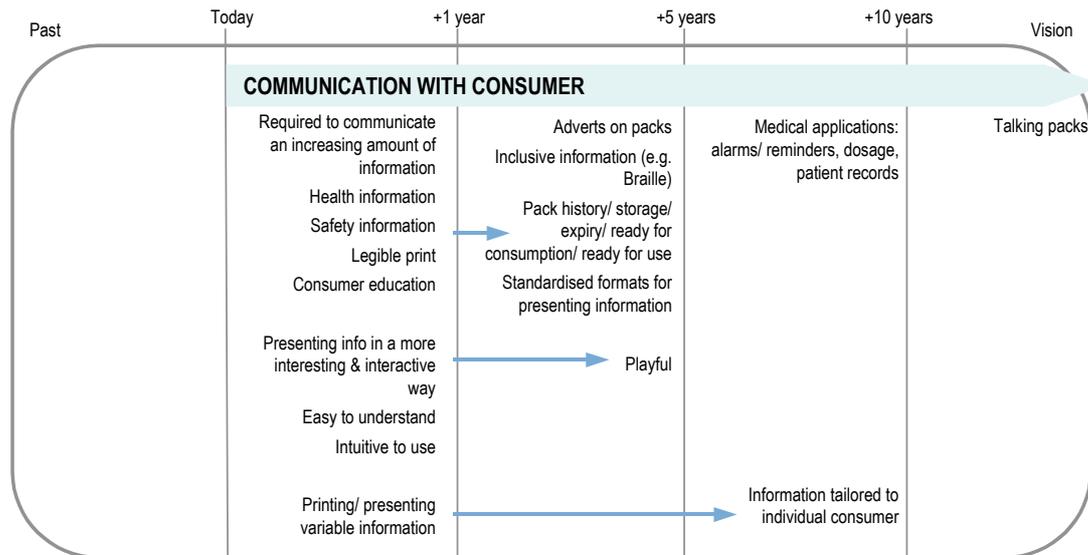
Packs are required to communicate an increasing amount of information. This includes health and safety information, as well as educating or warning consumers about a product. Further requirements may be to carry advertisements, or to incorporate ‘inclusive information’ such as Braille. Standardised formats for the extent and type of information that needs to be presented might also be developed.

Simple areas where there appears to be scope for some improvement are to ensure that print is legible and instructions are easy to understand. The packaging also has a role in making the use of the product intuitive to the consumer.

There are opportunities to use packaging to present information in a more interesting way. Interactive, playful, and talking packaging are examples of how this might be achieved.

Technical advances are also making it possible to communicate more information to consumers. It is possible to access the pack history, including the origin of the product, the environmental conditions that it has been exposed to, and when the contents are ready to be used/ consumed, or have or are likely to expire. It will also be possible to present variable information on packs that is tailored to the specific requirements and interests of individual consumers.

Improved communication functions will also have benefits for pharmaceutical products, This may include storing patient records, reminding patients when they are due to take medication, and the stating or diagnosing the dosage that they require.



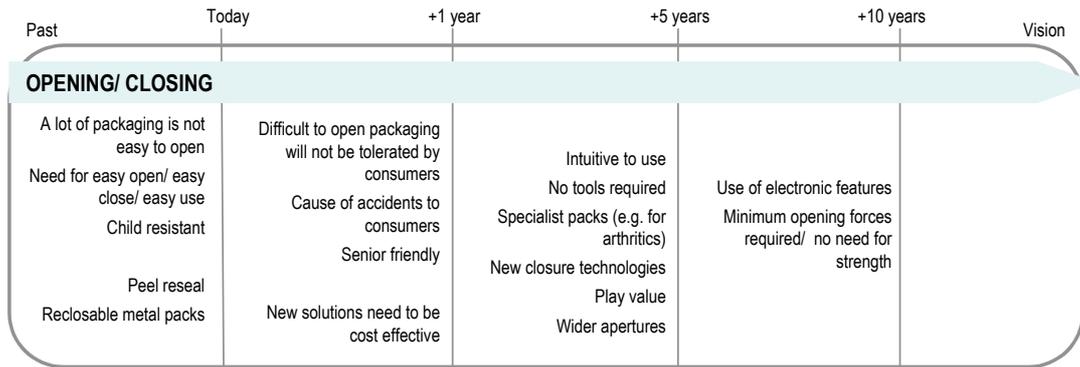
### III.2.3. Opening/ Closing

There is a general perception that a lot of packaging is not easy to open. This is a significant cause of accidents in the home, which is largely due to the fact that inappropriate and dangerous tools are used to access the contents of a pack. It is expected that consumers will reach a stage where they refuse to tolerate all difficult-to-open packaging. Hence there is a distinct need for packaging that is easy and intuitive to open, close and use. These solutions, however, must be cost-effective.

Child resistant openings are an important safety device, but these should not make it difficult for the intended consumer to use. A particular problem associated with these packs are that they disadvantage senior citizens, or people with impaired abilities. There is an apparent niche for specialist packs that accommodate these requirements, for example, packs for people with limited strength or grip.

Innovations in closures will also of great benefit to consumers. Developments such as reclosable metal packs, wider apertures, and films that can be peeled and resealed offer increased choice to brand owners and consumers alike.

The opening and closing of packaging should be a pleasurable experience for consumers. This may be heightened by increasing the 'play value' of a package, or by incorporating electronic features.

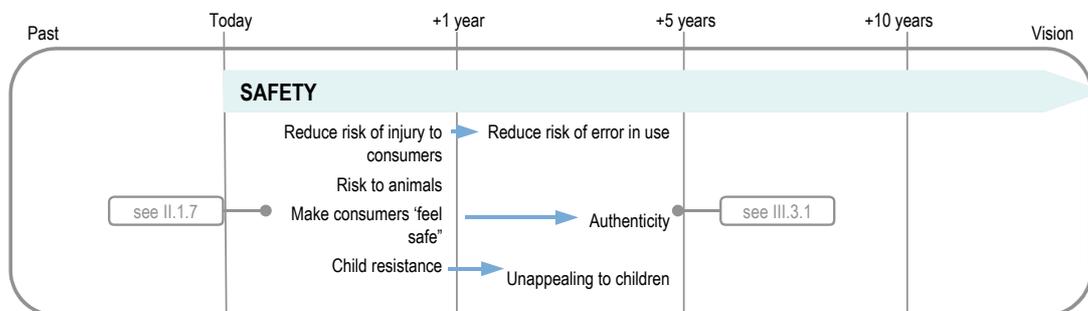


### III.2.4. Safety

Reducing the risk of injury to consumers can primarily be achieved by decreasing the likelihood of error in using a packaged product. There is also a duty to ensure that any other individual that may come into contact with a packaged product will not be adversely affected. This extends across the entire lifecycle of a product and encompasses alleviating potential harm from the contents of a package, as well as the package itself. A consideration that further extends these requirements is potential contact with animals, and the subsequent risk.

Child safety is an important aspect of this area. Packaging solutions are regularly being developed to protect children. A simple way to achieve this would be to use the packaging to make products unappealing to children.

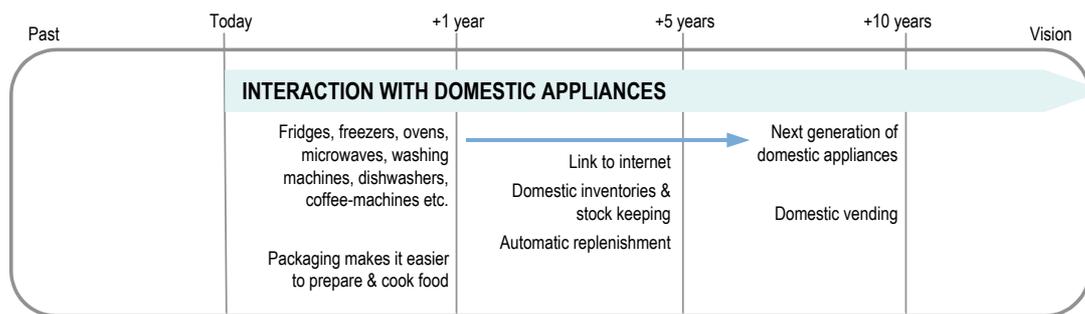
The pack has a role in making consumers feel safer. This can be achieved by incorporating features that prove a product’s authenticity and other security features that demonstrate that the contents of a pack are ‘safe’.



### III.2.5. Interaction with Domestic Appliances

Packaging interacts with a range of different domestic appliances, including fridges, freezers, ovens, microwaves, washing machines, dishwashers, and coffee-makers. There are also likely to be applications for packaging in future generations of domestic appliances. This could include domestic vending machines and home draught systems for refreshments.

The potential for a package to link to computers is seen to have possibilities for generating domestic inventories. This will enable consumers to monitor the stock of products that they have in their home, and also to access specific information such as the condition of these items (e.g. expiry date and temperature). In addition, links to the internet could be used to automatically order replacement items once products have been used or have expired.

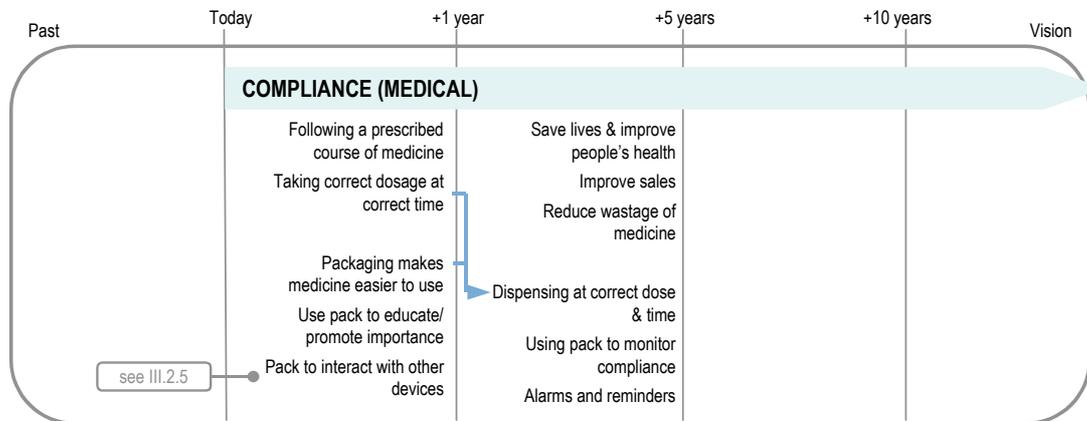


### III.2.6. Compliance (Medical)

Compliance is ensuring that patients follow a prescribed course of medical treatment. Packaging can contribute to this in a number of ways. Making medicine easier to take can make a significant contribution, as can making sure that the correct dosage is taken at the proper time. This could be facilitated by dispensing technologies and with reminders and alarms placed on the pack.

The packaging can also be used to educate patients of the importance of faithfully following the prescribed course of treatment and the pack could be used to monitor compliance. An example of this would be to record information such as when the medicine is taken, which could then be accessed by a patient or doctor.

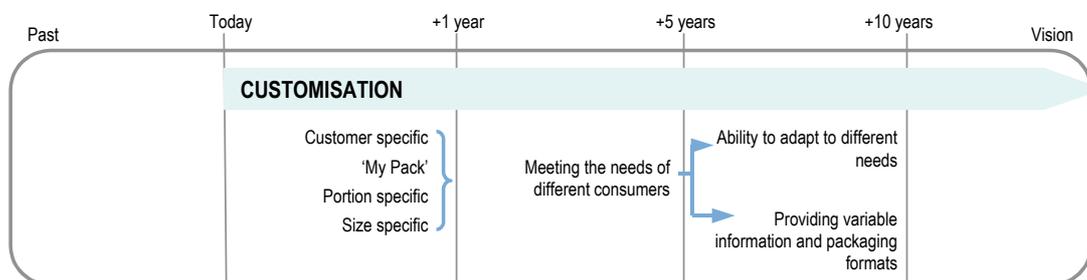
In addition to saving people’s lives this will lead to less wastage of medicine, and could potentially improve sales of pharmaceutical products.



### III.2.7. Customisation

Customisation is essentially concerned with meeting the needs of different consumers. This requires that packs satisfy or adapt to the requirements of individual consumers. This includes such things as providing appropriate portion and pack sizes, and presenting variable information that is tailored to the needs and interests of the individual.

‘Mass customisation’ is a concept where products and services are personalised for customers at a low cost. These initiatives are designed to increase the emotional involvement or attachment to products by making a consumer feel that it is ‘my pack’.



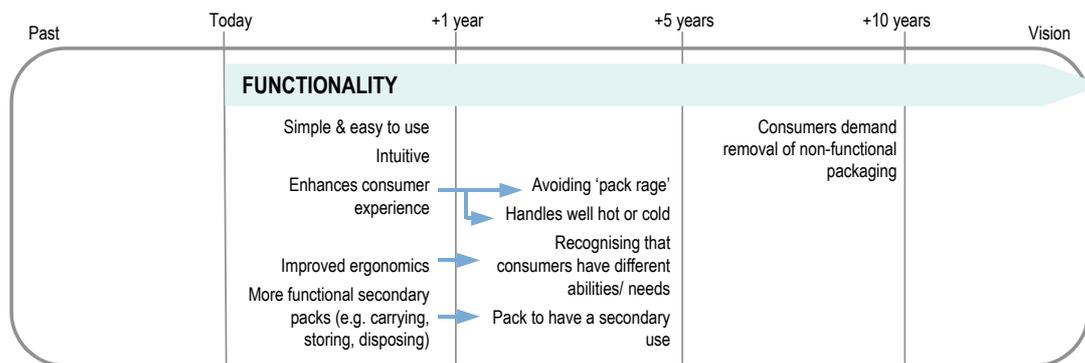
### III.2.8. Functionality

Packaging should be simple and easy to use. This demands that the pack is intuitive to use and is ergonomically sound. The pack should be designed to enhance the

experience of using a product, and avoid ‘pack rage’, which is a phenomenon associated with packaging that does not function to the satisfaction of a consumer. Another related issue that can frustrate consumers is excessive packaging, which is not perceived to serve any purpose.

It is necessary for a pack to function under different conditions. For example, a pack may need to be easily handled whether it is hot or cold. Pack design should also recognise that consumers have different levels of ability, and require that a pack accommodates or alleviates specific difficulties.

A pack may have functional properties that are not directly related to the use of a product, such as enabling easier carrying, storage or disposal. Other possibilities are for packaging to have a secondary use, such as becoming a toy or decorative item.



### III.3. Retail/ Transfer to Consumer

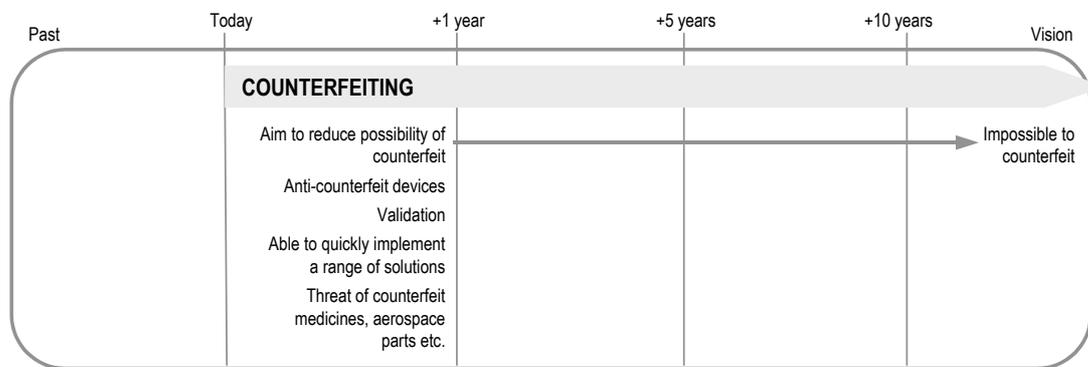
#### III.3.1. Security

There are a variety of security features that can be incorporated into packaging to serve a number of different purposes. These include: anti-theft devices, anti-counterfeit features, tamper-evidence, and tamper-proof packaging. A specific security application is for authentication when pharmacists dispense drugs.

### III.3.2. Counterfeiting

Counterfeiting has become a significant problem in many industries, including consumer goods and pharmaceuticals. Packaging can reduce the possibility of counterfeiting by making it difficult or expensive to copy certain features. These measures range from simple codes or serial numbers that are used for validation, through to more advanced devices that can be incorporated into a pack such as RFID or magnetic technologies.

In practice the most appropriate anti-counterfeiting solution is to implement a range of features and devices. The ultimate objective is to develop solutions that make it impossible to counterfeit products.



### III.3.3. Efficiency Gains

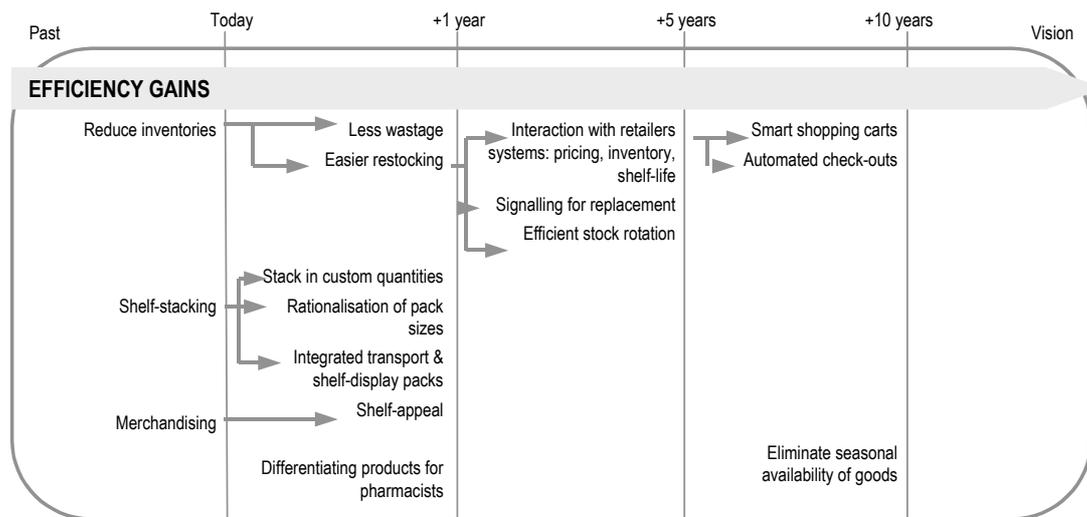
There are a number of areas where packaging can help to make the transfer of products to consumers more efficient.

Information and devices on packaging can make stock keeping more efficient. This includes generating inventories, reducing wastage, easier restocking and stock rotation. Features like signalling for replacement once a product has expired or been purchased, will come from the interaction of packs with other retail systems. Packaging will also play a role in making the process of buying goods easier by communicating with smart shopping carts and automated check-outs.

Packaging can make shelf-stacking easier by having integrated transport and shelf-display packs, or deliveries that are stacked in customised quantities for transfer onto

shelves. Rationalisation of pack sizes is another way in which this process could become more efficient.

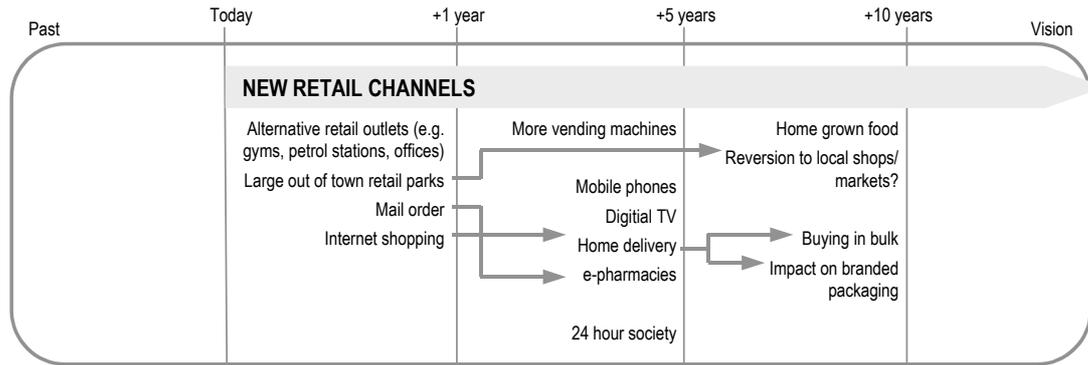
Packaging can be used to make it easier for customers to locate certain products by clearly differentiating them. This is also a consideration for pharmacists, as being able to clearly identify a product will make it easier to dispense to a customer. Packaging may also play a role in eliminating the seasonal availability of certain produce.



### III.3.4. New Retail Channels

Large out-of-town retail parks have become commonplace in many countries. Other retail outlets have also become more prominent, such as gyms, petrol stations and offices. It is possible that consumers may choose revert to local shops and markets, or even begin to grow food at home. All of these changes will influence the types of products and packaging that consumers require.

It is believed that there will be an increase in the amount of goods sold in vending machines, and that mail order and internet shopping will continue to grow in popularity. This form of shopping, and other portals such as mobile phones and digital television, will increase the amount of goods that are delivered to the home. This may change the types and quantities of products that people buy. For example, home delivery may encourage people to buy in bulk. It may also reduce the importance of branded goods and packaging, as people will have already purchased the product when they finally come into contact with it.



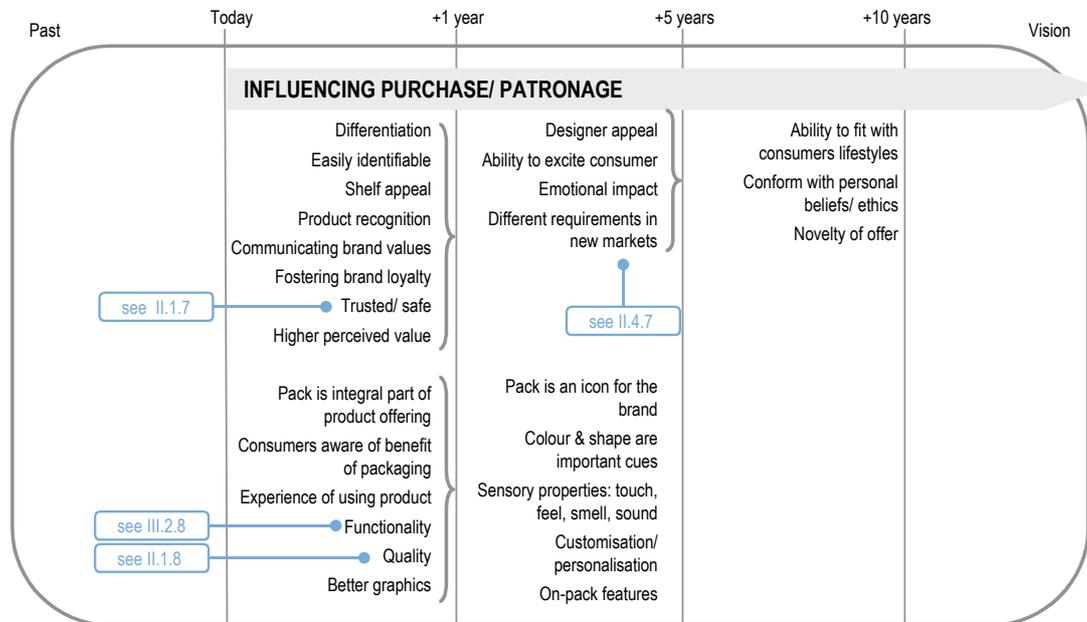
### III.3.5. Influencing Purchase / Patronage

A key objective for packaging influencing a purchase decision is to differentiate a product from the competition. This requires that the product is easily identifiable and recognisable, has ‘shelf-appeal’ and clearly communicates the values of the brand. The packaging can also be used to communicate ‘quality’ or a higher ‘perceived value’ to the consumer. The pack should make some kind of emotional impact on the consumer, such as excitement. This will be strongly linked with the associations that a consumer makes with a brand or the on-pack cues.

The pack should serve as an icon for the brand, fostering brand values and promoting a sense of trust and safety. The way that the product fits with the consumer’s lifestyle will also be a factor, such as ‘designer appeal’ or conformance with their ethical values or beliefs. This is a particularly important consideration with respect to the demands and challenges associated with satisfying consumer requirements in new markets.

The pack is an integral part of a product offer, and if consumers are aware of the benefit of a certain type of packaging, it may affect their decision to select a product. This will be strongly linked to the experience of using a product, and how the packaging functions or performs. Consumers will be influenced by the sensory properties associated with a product, such as feel, smell, sound and taste. The packaging can play a major role in emphasising, communicating or even creating these sensory properties. The appearance of the product is also important, such as the colour and shape of the packaging, as well as the graphics.

‘On-pack features’ such as electronics, or customisation and personalisation are seen as ways of promoting a product. This is strongly linked to the recognition of the importance of novelty in differentiating a product from the competition, or encouraging patronage of a brand.



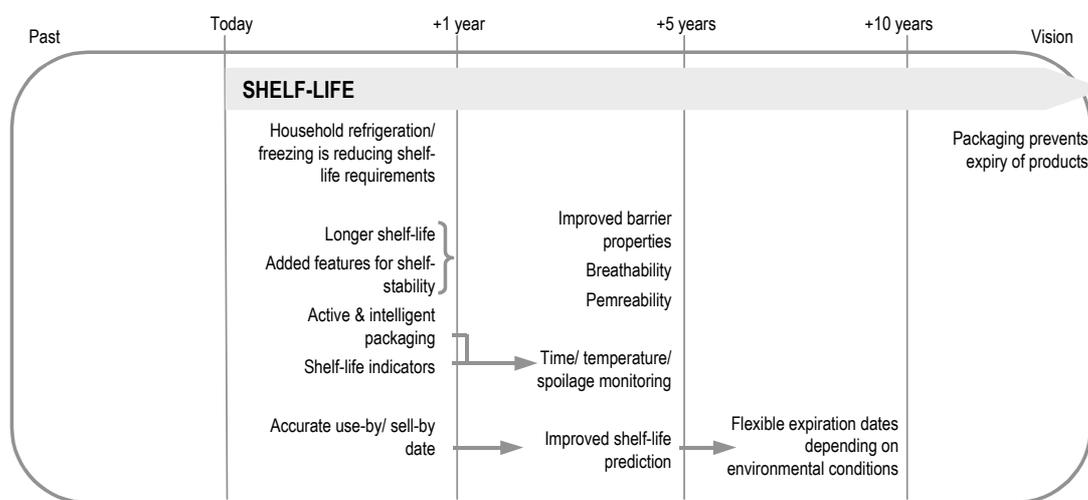
### III.3.6. Shelf-Life

Packaging plays a major role in extending the shelf-life and maintaining the stability of perishable products such as pharmaceuticals and foodstuffs. Examples of stability concerns are: oxidation; vitamin and nutrient loss; protein degradation; loss of flavour; changes in texture; migration of moisture, fats or sugar; and microbial stability. Examples of packaging features that can counteract these effects are barrier properties, breathability and permeability. In the future, these features may result in packaging preventing the expiry of all perishable products.

Active and intelligent packaging also has applications in controlling the atmospheric conditions of products. A further advantage of these technologies is that they can monitor and communicate the conditions to which a product has been exposed. These ‘shelf-life indicators’ can inform the consumer and retailer of factors such as time/ temperature exposure, and damage or spoilage.

A major benefit of these indicators is that they can improve shelf-life prediction, whereby consumers and retailers are given accurate use-by and sell-by dates, which are flexible, depending on the environmental conditions to which a product has been exposed.

Refrigeration and freezing of products in shops and at home greatly alters the demands of packaging in relation to shelf-life. Changes in habits and technologies in this area will affect the requirements of packaging, and may even reduce its role in protecting perishable products.



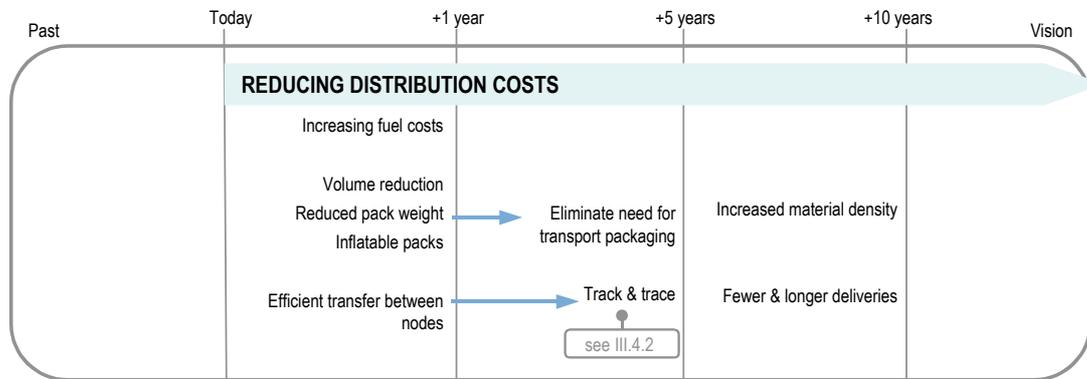
### III.4. Transport and Storage

#### III.4.1. Reducing Distribution Costs

There are two key areas in which packaging can play a role in reducing distribution costs. The first is reductions in volume and weight of packaging. This includes reductions in the product packaging, as well as reducing transport packaging. Possible solutions are the use of inflatable packaging, and improving primary packaging with a view to eliminating the need for transport packaging.

The second area where packaging can reduce distribution costs is by improving the efficiency of this process. The packaging can enable easier transfer between nodes, for example by enabling easier loading/ unloading, and also by use of track and trace technologies. The packaging may also play a role in enabling fewer and longer

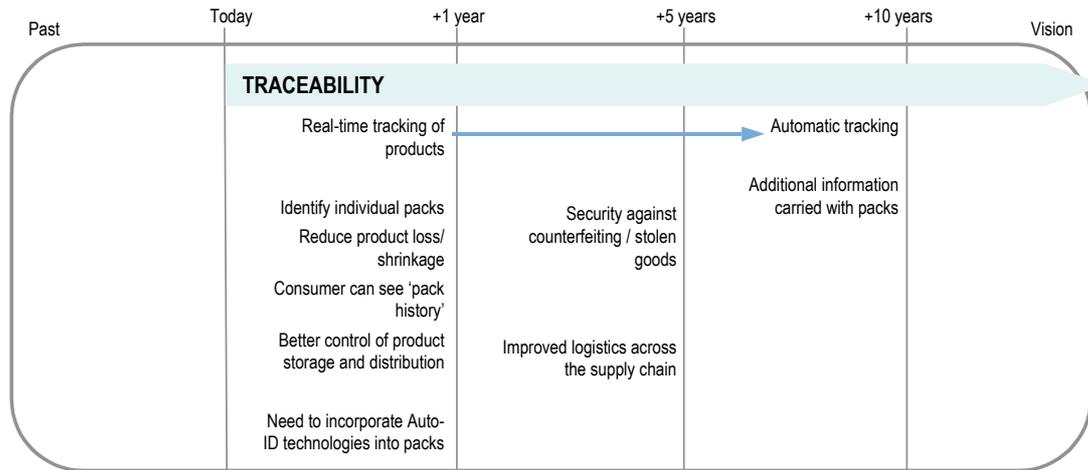
deliveries of goods. An example would be preserving perishable goods for extended periods of time.



### III.4.2. Traceability

Track and trace technologies enable real-time tracking of products. This is likely to be at pallet-level in the short-term, but will eventually be extended to item-level. The ability to identify individual packs will make it easier to recall products, and enable consumers to access the ‘history’ of a packaged product (e.g. date and place of manufacture, transportation, exposure to different environmental conditions, etc.) This will also make it easier to manage the storage and distribution of goods, and improve logistics across the entire supply chain.

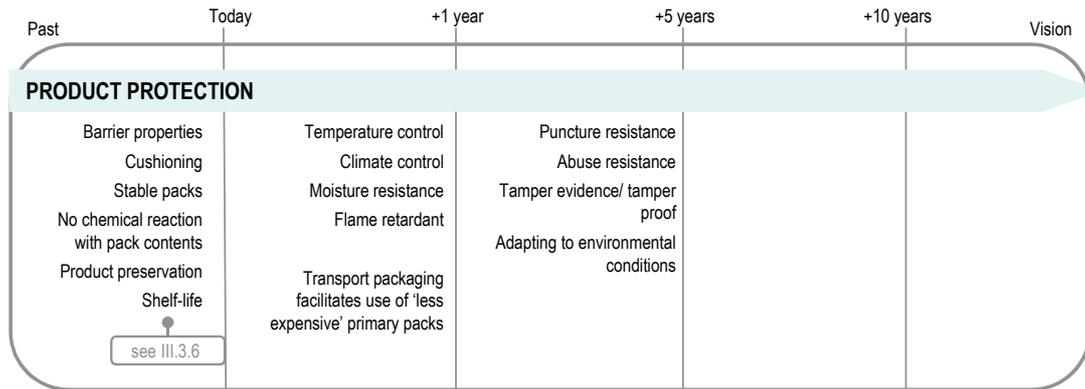
The ability to track and trace products will be beneficial in reducing shrinkage (i.e. goods that are lost, stolen, or become obsolete) and in safeguarding against counterfeiting. This will require that identification technologies are incorporated into packaging.



### III.4.3. Product Protection

The primary purpose of a package in transport and storage is to ensure the integrity and safety of its contents. The range of functional properties that are required to achieve this will vary between different applications, but there are a number of generic considerations. Structurally, the package needs to be stable, protect against impacts and external forces, and provide a barrier to the external environment. The pack must not react with its contents, and should maintain the properties of a product through such measures as temperature and climate control. Other ways in which a pack may be required to protect its contents are flame retardance and resistance against moisture, puncture and abuse. As these conditions are variable, and can differ greatly between applications, it would be a distinct advantage if packaging could adapt and react to different environments.

The demands placed on primary packaging will be greatly affected by the extent and type of transport packaging used. Advances in this area may facilitate the use of less 'expensive' primary packs.



## III.5. Manufacturing

### III.5.1. Materials

A specific objective for the development of new materials is for them to be more cost effective. This includes the actual cost of the materials, and also associated costs, such as enabling the use of more cost effective production systems. These kinds of advances will result in existing materials being displaced by new alternatives.

Other basic objectives include improved protection of products, and guaranteeing a level of quality.

A range of issues will influence the materials that are selected or developed for different applications. This includes solving specific problems such as photoxidation of beer in transparent bottles and also the ability to respond to changing requirements, such as considering the implications of disposal, recovery and recycling. Other similar considerations are biodegradability, and whether the raw materials come from a renewable source.

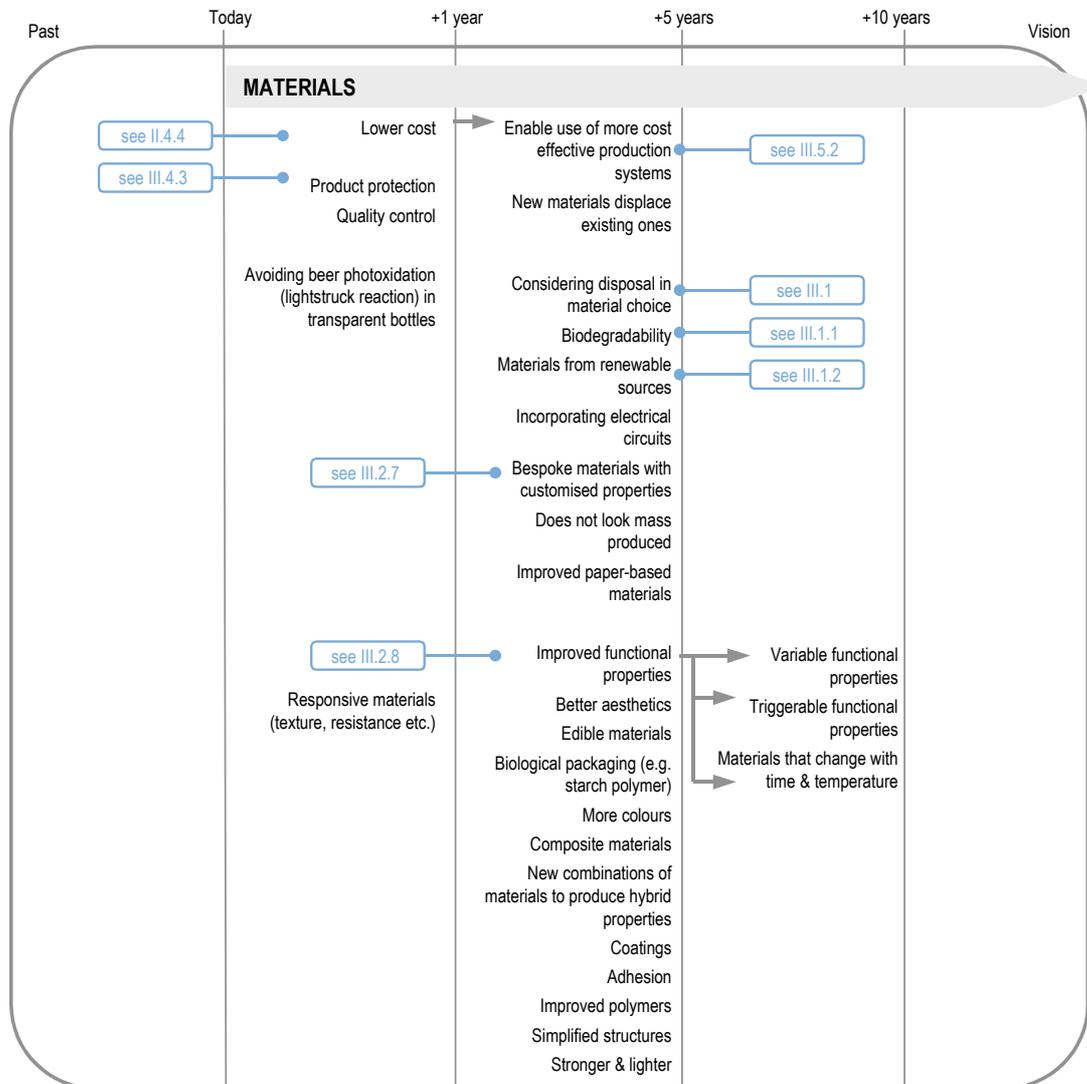
Advances in materials will enable features such as electronics to be easily and cost effectively incorporated into packaging.

There will be a demand for bespoke materials that have customised properties and do not look mass produced.

The properties of existing materials will be enhanced, such as improved paper-based packs. Functionality will be improved, and advanced to enable variable and triggerable properties. An example is materials that can change over time or in response to different environmental conditions.

Aspirations for improvements include: more responsive materials (e.g. texture and resistance); improved polymers and blends of polymers; better aesthetics; more colours; simplified structures; and stronger and lighter materials. Some of these objectives will be satisfied by the hybrid properties of new composite materials.

In addition to developments in raw materials, there will also be advances in coatings and adhesives.



### III.5.2. Production

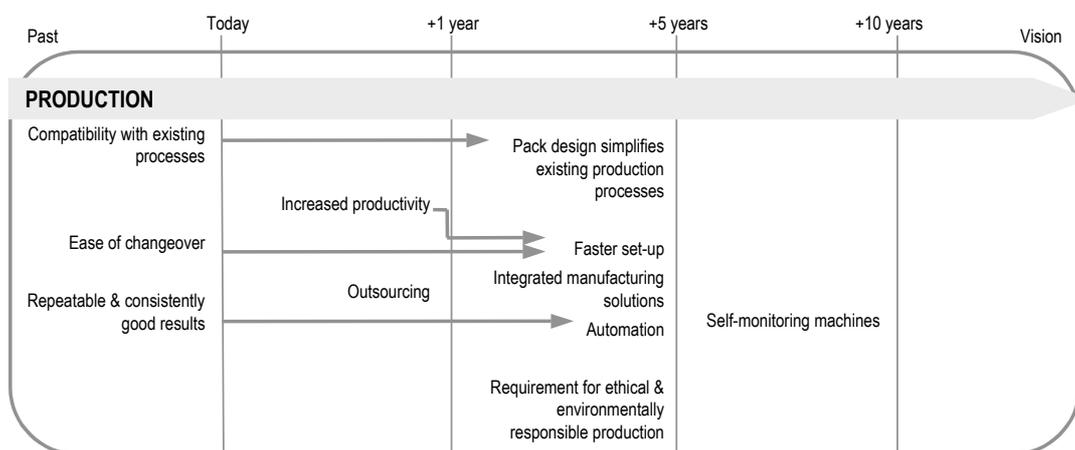
An important consideration for any new developments in production is that they conform with existing processes and capabilities. An additional objective is to simplify existing production processes. This should be a major consideration in the design of new packaging solutions.

Improved productivity is a common aspiration, and is strongly linked to the ease and speed of changeover and set-up on production and packing lines.

A further objective in production is to produce repeatable and consistently good results. This may be achieved by increased automation, with a specific example being self-monitoring machines.

There is increasing attention towards integrated manufacturing solutions. There will also be more outsourcing of production.

There will be greater accountability for production processes, which will require manufacturers to demonstrate that they have adopted ethical and environmentally responsible practices.



# IV. Technology Insights

## IV.1. Products

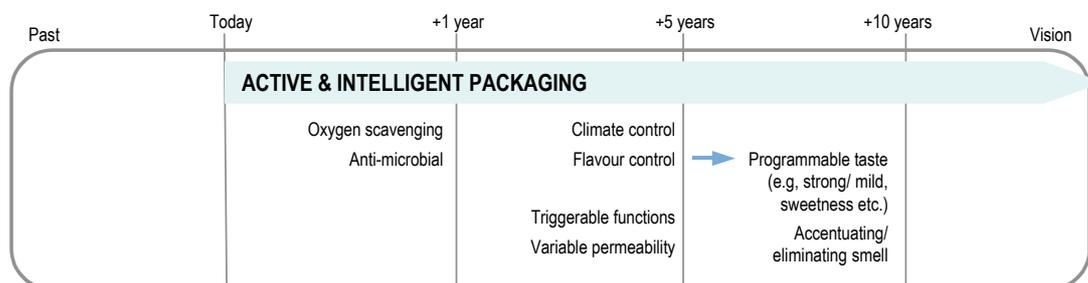
### IV.1.1. Active and Intelligent Packaging

‘Active packaging’ regulates the conditions of a packed product for such purposes as prolonging shelf life and improving safety and quality. These functions include oxygen scavenging; inhibiting growth of microorganisms; and control of climate, flavour and odours.

‘Intelligent packaging’ functions switch on and off in response to changing internal/external conditions, and can be communicated in some way to the consumer.

The combination of these active and intelligent features enables packs to have ‘smart functions’ such as variable permeability and light (photochromic) protection. A more advanced level of functionality would be to enable properties such as taste and smell to be programmed. This would enable consumers to adjust properties such as strength and sweetness to their own tastes.

Intelligent packaging also incorporates indicators that communicate the status of the pack contents.

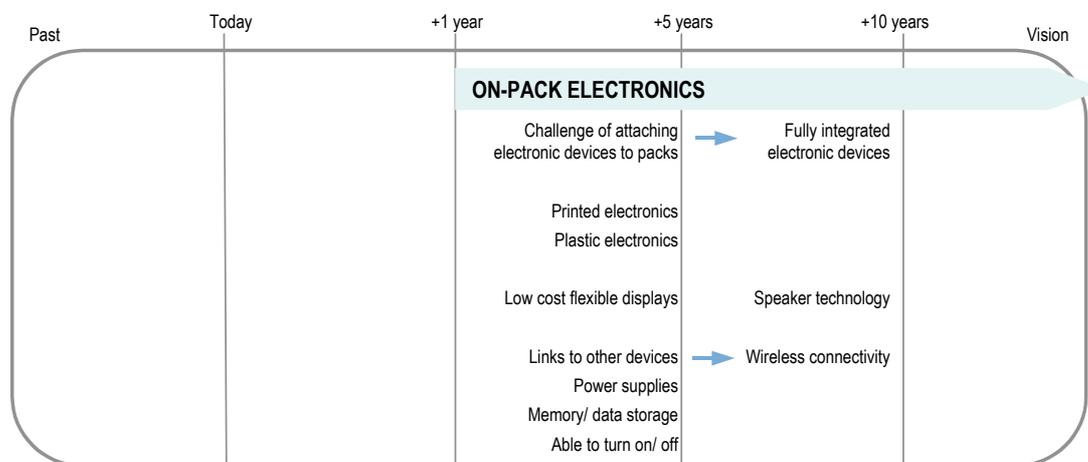


### IV.1.2. On-pack Electronics

There are a range of electronic devices that will be incorporated into packaging. This includes devices such as batteries, power supplies, antennae, memory and data storage. Electronic communication devices such as displays, speakers and microphones will also become increasingly common in packaging. Electronic sensors will be used for different monitoring purposes and antennae will enable wireless interaction with other electronic devices.

An initial challenge is how to incorporate or attach electronic devices into/ onto packs. This will eventually be done in such a way that these devices are fully integrated into the packaging. This will require that these devices are flexible in certain applications.

A further challenge is to make these items at a sufficiently low cost. This may be achieved using printed and plastic electronics, and will enable developments such as disposable games and electronic toys.



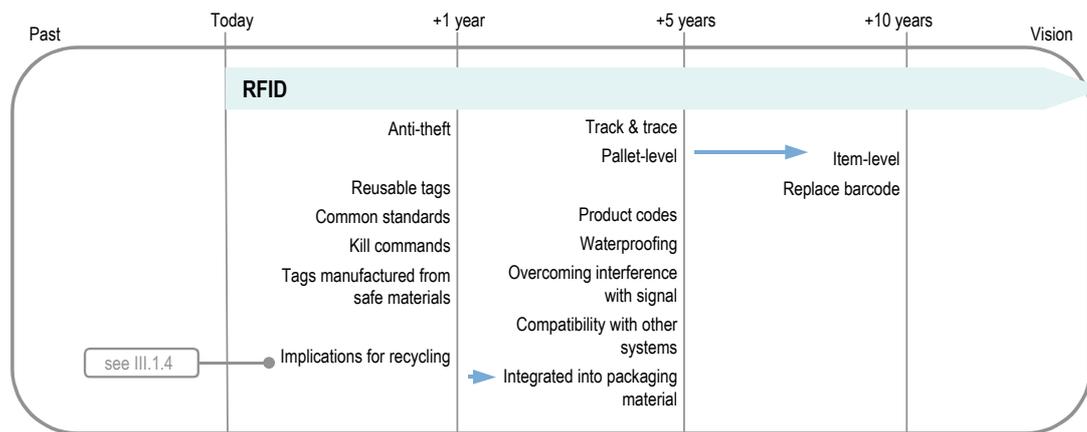
### IV.1.3. Radio Frequency Identification

Radio Frequency Identification (RFID) tags are devices that communicate a unique code to a reader, which enables items to be identified remotely. This has a number of applications, ranging from supply chain management, to protection against theft. It is anticipated that this technology will eventually replace the barcode.

There are a number of considerations related to the use and development of RFID tags. Common standards and product codes need to be rolled out. Tags may need to be compatible with different systems, and the problem of interference with signals poses a significant challenge. Preventing damage to the tags is another consideration, and will require protective measures such as waterproofing.

How the tag is attached or integrated into a pack will also represent a challenge. This will have implications for how easily a tag can be separated from a package for reuse or recycling (of the tag and/or pack).

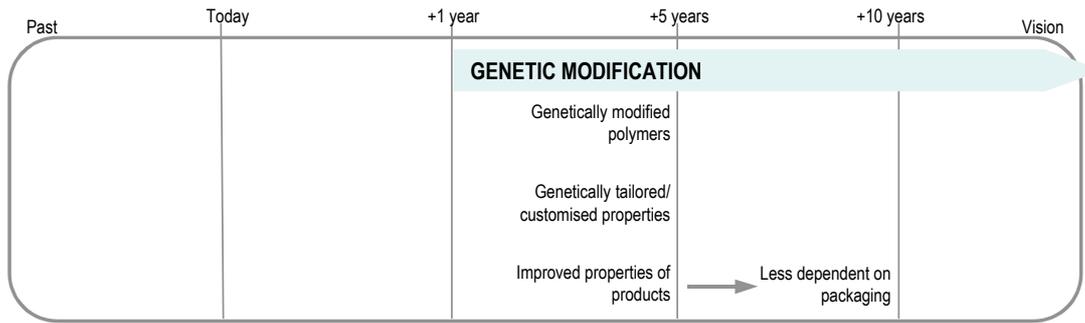
In the short-term, the cost of tags is seen to be prohibitive. As a result of this, tags will be applied at pallet-level in the near future, but item-level tagging will be more of a longer-term consideration.



#### IV.1.4. Genetic Modification

Genetic modification of polymers and packaging materials will improve their functional properties, and enable customisation.

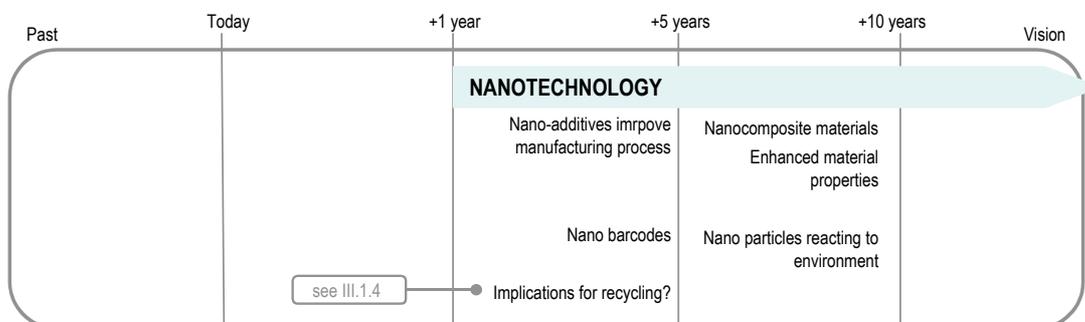
Genetic modification of consumer products will also improve the properties of consumer products, which may decrease the need for packaging of certain products, such as particular foodstuffs.



### IV.1.5. Nanotechnology

The term ‘nanotechnology’ encompasses a large sphere of activities that are concerned with the creation of small materials and devices at a molecular scale. The main applications of nanotechnology in packaging will be in enhancing material properties. This includes nanoclay technologies, which will improve the characteristics of materials (e.g. improved thermal stability and barrier properties) and nano-tubes, which will primarily be used to increase strength. It is likely that many of these properties will come from nanocomposites, which will produce new and innovative materials structures and performance. These materials will also be able to change properties depending on external or internal conditions to which they are subjected.

Nanobarcodes will be used as a covert tag for anti-counterfeiting application. There are concerns over how these materials will be recycled, and whether they will retain previous tags. However, nanotechnology also has the potential to improve the recyclability of materials, and make the process more efficient.

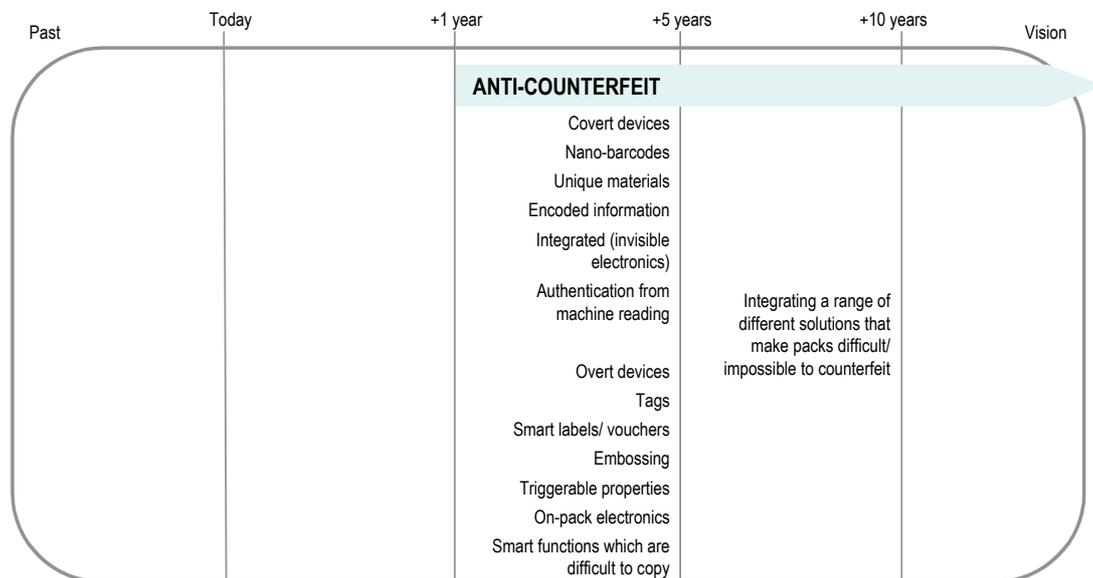


### IV.1.6. Anti-Counterfeit

Anti-counterfeit features can be either covert or overt. Examples of covert devices include: nanobarcode, use of unique materials (e.g. nanocomposites), encoded information, integrated electronic features, and machine-readable authentication.

Overt devices include: tags, labels and vouchers; embossing; on-pack electronics; triggerable properties; and a variety of other ‘smart’ functions.

In practice, the most appropriate way to prevent counterfeiting is to implement a combination of different solutions that make packs difficult, or preferably impossible to counterfeit.



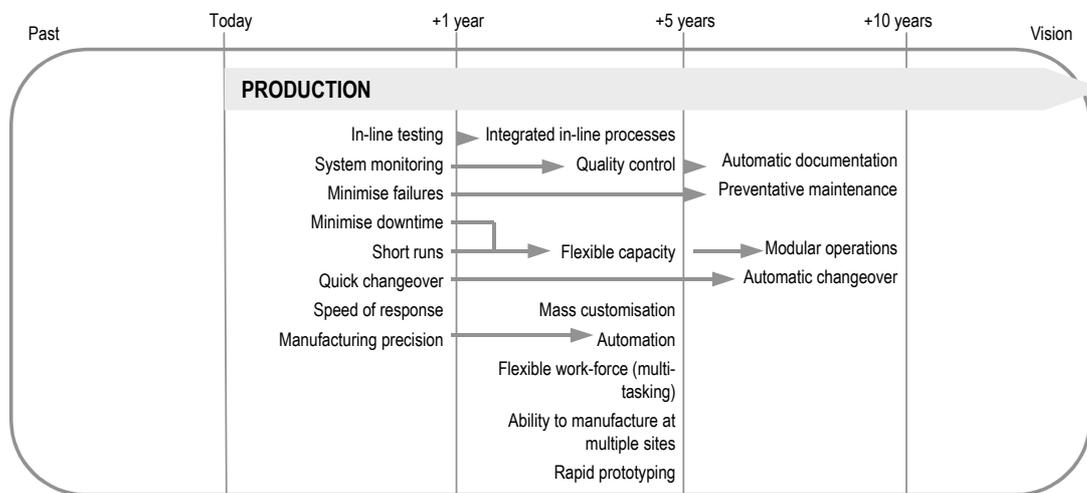
## IV.2. Processes

### IV.2.1. Production

A reduction in machine ‘downtime’ (periods of inactivity) is a key objective in production. This can be achieved by minimising failures (e.g. by preventative maintenance) or by improving the speed of changeover (e.g. by automation or modularisation). This will enable shorter manufacturing runs, a more flexible production capacity and a faster speed of response.

In addition to producing things quickly, it is also desirable to maintain quality. Advances in system monitoring, in-line testing and production of automatic documentation, will be beneficial in this area. Developments in manufacturing precision and automation will also make a significant contribution.

An organisation's asset base will greatly affect production, and will impact the products that they produce. This includes factors such as whether it is possible to manufacture a product at multiple sites, and the skills and flexibility of a workforce. However, it is likely that increased automation will reduce labour requirements in production.

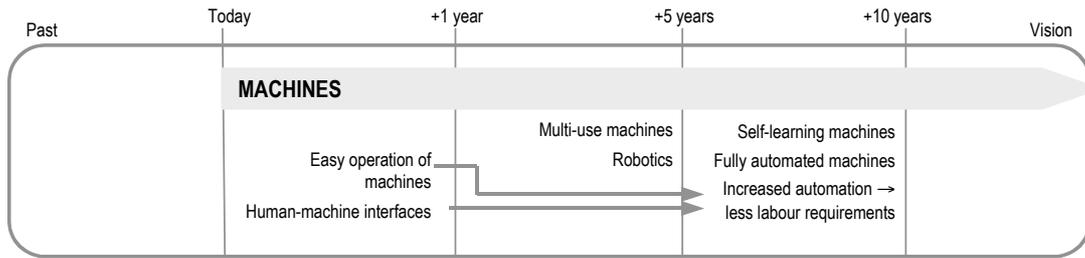


#### IV.2.2. Machines

Machines should be easy to operate and maintain. A major factor in facilitating this is the machine interface.

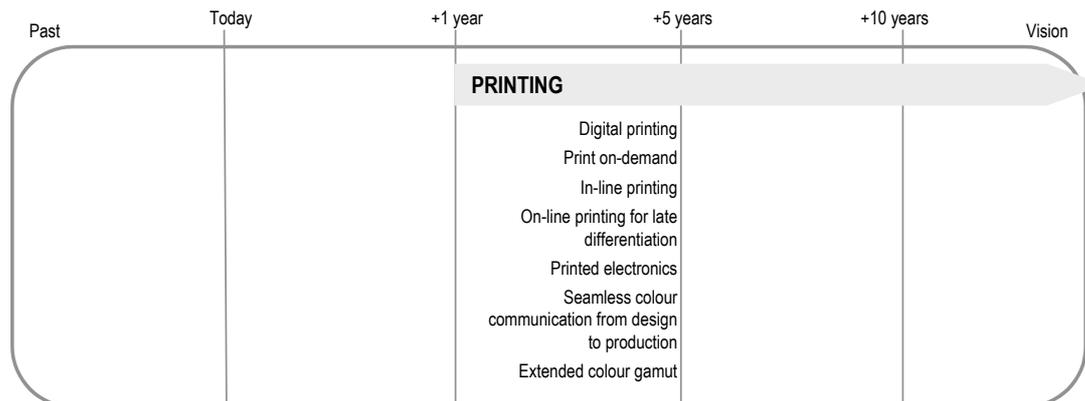
Increased automation of machines may make this interface less important in the future. This will culminate in fully-automated and self-learning machines.

Integrated in-line processes, multi-use machines, and an increased use of robotics are also likely developments.



### IV.2.3. Printing

A number of advances in printing will impact consumer packaging. This includes digital printing, which will have such benefits as improved colour communication and more detailed and accurate outputs. In-line printing will enable late customisation of products, and printed electronics will enable low-cost electronic devices to be incorporated into packs.



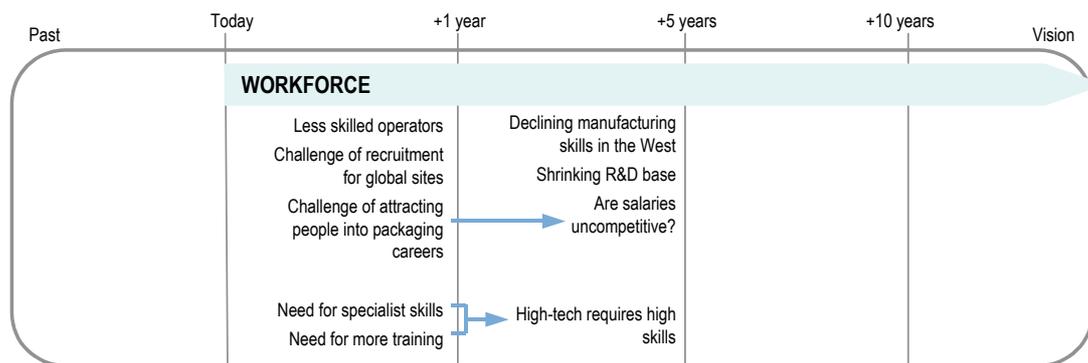
# v. Resource Insights

## V.1.1. Workforce

As products and processes become more ‘high-tech’, more specialist skills will be required and there will be a greater need for training.

Recruitment is seen to be a major problem. There is a shortage of skilled personnel at all levels, and it is proving difficult to attract people into packaging careers. This has raised the question whether current salaries are uncompetitive.

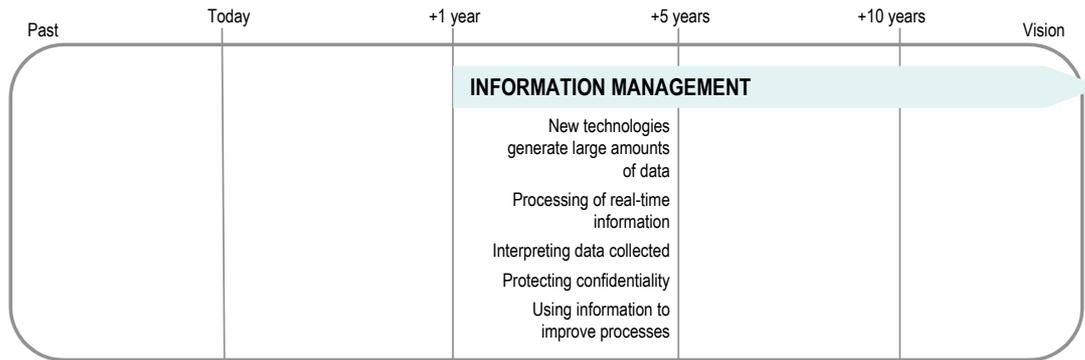
Recruiting personnel for global sites is also seen as a challenge. There is also an awareness of the possible future implications of the decline of manufacturing in the West, and the reduction in research and development in many companies.



## V.1.2. Information Management

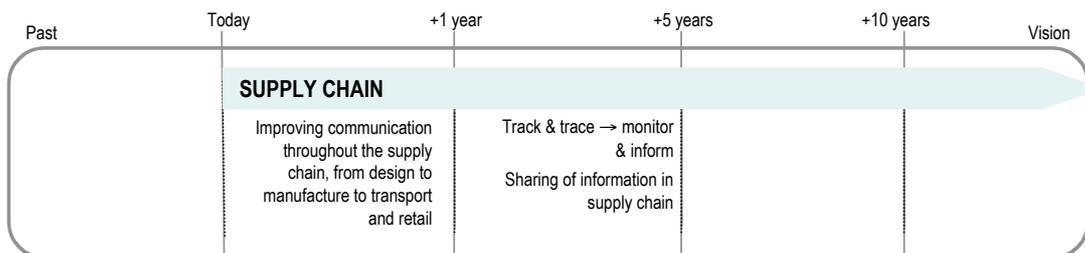
Many new technological developments, such as RFID, will result in an increase in the amount of data generated. This will require real-time processing and interpretation of large amounts of information. A specific benefit of this will be enabling the improvement of various processes.

A major consideration that will affect how this information is managed will be confidentiality.



### V.1.3. Supply Chain

A key objective is to improve communication throughout the supply chain. This encompasses design, manufacture, transportation and retail. Track and trace technologies will make it easier to integrate processes between different companies, but this will require systems and procedures for sharing information.

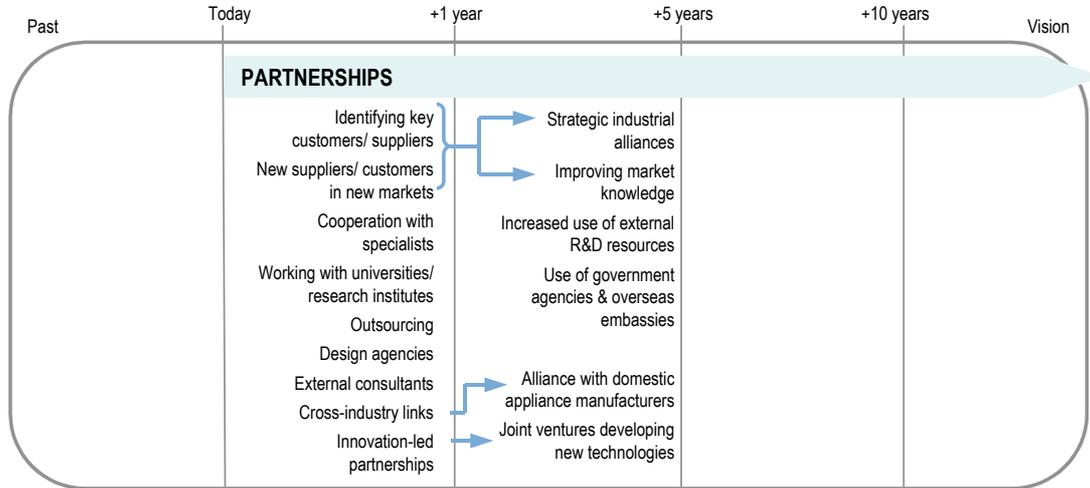


### V.1.4. Partnerships

Strategic industrial alliances will become increasingly important. Identification of key customers and suppliers, and partnerships with new suppliers/ customers in new markets will deliver benefits such as improved market knowledge. An additional source of market knowledge are government embassies overseas.

There will also be more cooperation with experts who have specialist skills. This includes consultants, design agencies, universities, research institutes, and other external research and development resources. An increase in outsourcing will also make strategic partnerships more important.

There will be an increase in innovation-led partnerships to develop new products and technologies. There will also be more cross-industry links, such as alliances with domestic appliance manufacturers.



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